March 1957

VOL. 69, No. 1 PAGES 1–120

The Wilson Bulletin

Published by

The Wilson Ornithological Society

at

Lawrence, Kansas

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Founded December 3, 1888

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THE WILSON BULLETIN

The official organ of The Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Lawrence, Kansas. The subscription price, both in the United States and elsewhere, is $3.00 per year, effective in 1957. Single copies, 75 cents. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at 50 cents each for 1950 and earlier years, 75 cents each for 1951 and subsequent years) and may be ordered from the Treasurer.

All articles and communications for publication, books and publications for review should be addressed to the Editor. Exchanges should be addressed to The Wilson Ornithological Society Library, Museum of Zoology, Ann Arbor, Michigan.

Entered as second class matter at Lawrence, Kansas. Additional entry at Ann Arbor, Mich.

THE WILSON BULLETIN

A Quarterly Magazine
of
Ornithology

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Volume 69
1957

Published
by
THE WILSON ORNITHOLOGICAL SOCIETY

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Vol. 69, No. 1 | March 1957 | Pages 1–120

CONTENTS

Plumages of the Redhead, painting by *Milton W. Weller* ..... facing p. 5

Growth, Weights, and Plumages of the Redhead, *Aythya americana* ..... *Milton W. Weller* 5

The Relative Magnitude of the Trans-Gulf and Circum-Gulf Spring Migrations ..... *Henry M. Stevenson* 39

Some Observations on Sun-bathing in Birds ..... *Doris C. Hauser* 78

Methods and Criteria for Aging Incubated Eggs and Nestlings of the Mourning Dove ..... *Harold C. Hanson and Charles W. Kossack* 91

Status of Brewer's Blackbird on the Grand Prairie of Eastern Arkansas ..... *Johnson A. Neff and Brooke Meanley* 102

General Notes

Notes, chiefly distributional, on some Florida birds ..... *Kenneth C. Parkes* 106

Golden Eagle attacks decoy duck ..... *Charles C. Sperry* 107

Telmatodytes palustris plesius wintering in southwestern Kansas ..... *Glen E. Woolfenden* 108

"Frightmolt" in a male Cardinal ..... *Mary Juhn* 108

New bird records for Barbuda, British West Indies ..... *G. A. Seaman* 109

Status of the stolid flycatcher in the American Virgin Islands ..... *G. A. Seaman* 110

A peculiar type of flight in Cooper's Hawks ..... *Daniel D. Berger* 110

Effects of unusual spring weather on Scarlet Tanagers ..... *Richard H. Manville* 111

Hudsonian Godwit in Colorado ..... *Alfred M. Bailey* 112

Water Moccasin preys on Pied-billed Grebe ..... *B. B. Leavitt* 112

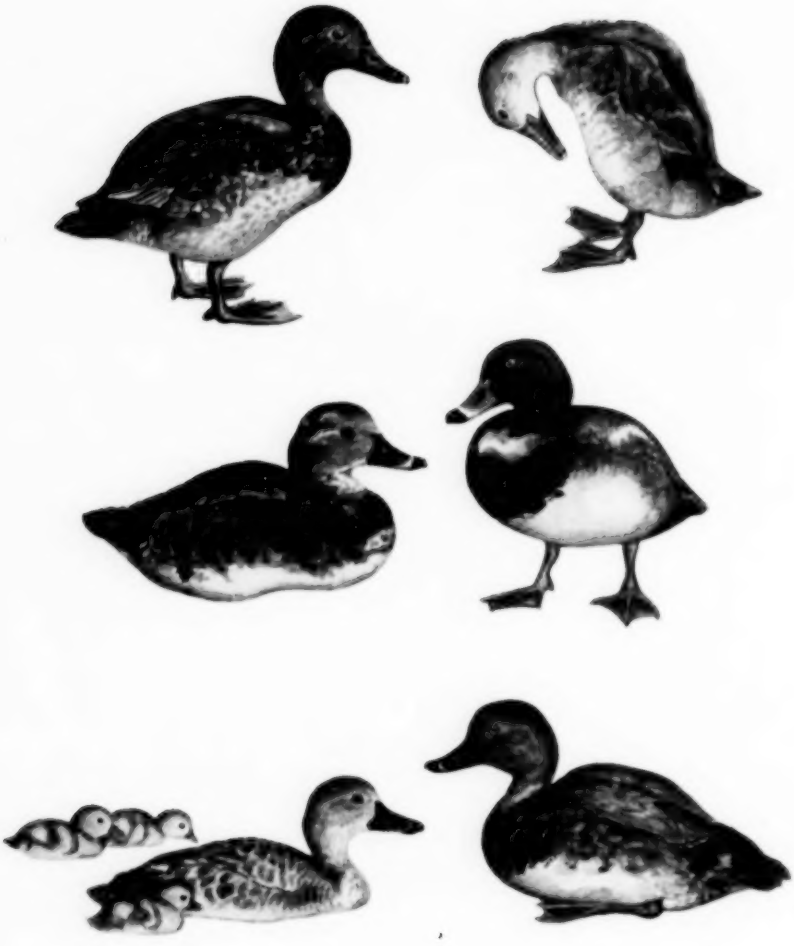
Egg-carrying by the Whip-poor-will ..... *Laurence Kilham* 113

Varied Thrush in Texas ..... *Mary Belle Keefer* 114

Wilson Society News 115

Ornithological Literature 117

Durward L. Allen (Editor), *Pheasants in North America*, reviewed by Robert A. Pierce; L. R. Wolfe, *Check-list of the Birds of Texas*, reviewed by Keith L. Dixon; T. C. Stephens, *An Annotated Bibliography of North Dakota Ornithology*, reviewed by O. A. Stevens.



PLUMAGES OF THE REDHEAD, *Aythya americana:*
Upper left, male four months of age in postjuvenal molt
Upper right, male ten weeks of age
Middle left, adult female in spring
Middle right, adult male in winter and spring
Lower left, adult female in summer with day-old chicks
Lower right — Eclipse plumage of one-year-old male

GROWTH, WEIGHTS, AND PLUMAGES OF THE REDHEAD, *AYTHYA AMERICANA*[1]

BY MILTON W. WELLER

DESPITE the intense interest in waterfowl shown by aviculturists, ornithologists, wildfowlers, and wildlife managers, surprisingly little has been published concerning their growth, weights, and plumage development. Growth and plumage development probably have been studied little because the precocial young are difficult to examine periodically in the wild, and few investigators have reared waterfowl for growth studies. At the Delta Waterfowl Research Station, in southern Manitoba, excellent facilities are available for rearing many species of ducks. This equipment was used during the present study to investigate the growth of the young Redhead (*Aythya americana*). Some of the birds were held in captivity as long as five years in order to observe plumage changes in adults. In addition, data were gathered on plumages and weights of wild adults during a concurrent study of the breeding biology of the Redhead.

ACKNOWLEDGMENTS

I am indebted to Dr. William H. Elder and H. Albert Hochbaum for advice throughout the study. Peter Ward and other staff members of the Delta Station were most helpful. Arthur S. Hawkins, George Dellinger, Thomas Bergerud, and Michael Milonski assisted in various phases of the study. Margaret M. Nice was most helpful in referring me to sources in the literature and Dr. Samuel Brody and Professor Benjamin Frame of the University of Missouri gave advice on statistical methods.

Unpublished field data were provided by Alex Dzubin, Peter Hanson, and Herbert J. Miller (Michigan Federal Aid Waterfowl Research Project 45-R).

I wish to thank Dr. Elder, Dr. Thomas S. Baskett, and John P. Rogers of the Missouri Cooperative Wildlife Research Unit for reading the manuscript.

MATERIALS AND METHODS

Sources of birds and hatchery techniques.—Eggs were collected from nests of wild Redheads and placed in still-air incubators at 99° F. Newly hatched ducklings were held in the incubators until dry. In 1952, the ducklings were put in small, heated pens and later in larger enclosures. In 1953, they were placed in a pen under heat lamps and the pen was enlarged as the birds

[1] Contribution from the Delta Waterfowl Research Station and the Missouri Cooperative Wildlife Research Unit: U.S. Fish and Wildlife Service, Wildlife Management Institute, Missouri Conservation Commission, Edward K. Love Foundation, and the University of Missouri cooperating. Grants were received from the E. S. Stephens Fellowship Fund, the University of Missouri, and the Delta Station.

grew. At six to seven weeks of age they were moved to an outdoor enclosure large enough to permit flying. Adults were held in a heated building in winter and spent the summer outdoors in large enclosures.

Juveniles were fed turkey pellets and hard-boiled egg until two weeks old, then large poultry pellets and natural foods, such as duckweed (*Lemna minor* and *L. trisulca*). Adults were fed poultry pellets, cereal grains, and duckweed.

Observations of wild juveniles were obtained in two ways. Ducklings were dyed in the egg in the manner described by Evans (1951) and later observed and collected. In addition, ducklings captured in banding traps of the U.S. Fish and Wildlife Service were measured and marked. Birds too small to be banded were toe-punched. Marked Redheads habitually returned to the traps for food and were re-measured when a period of at least one week had elapsed between the original marking and the recapture.

Wild juveniles and adults were obtained in various parts of Manitoba from banding traps of the U.S. Fish and Wildlife Service, the Delta Waterfowl Research Station, and Ducks Unlimited. Nesting females were weighed and examined by the author in Manitoba in 1954 and 1956 and in Utah in 1955. At first they were captured with a drop trap similar to that described by Sowls (1949) and later with an automatic trap with a drop-door released by the hen when she entered (Weller, 1957).

Birds taken by hunters in the Delta Marsh and at Lake Winnipegosis during 1952 and 1953 also were examined.

Measurements.—Sizes of the samples of birds measured are shown by sex and age in Table I. During 1952, the growth of 55 hatchery-reared Redheads was studied. Birds were weighed weekly for the first 10 weeks, and then at 12 and 16 weeks of age. During 1953, Redheads were weighed at weekly intervals until 10 weeks old.

Weights of juveniles were recorded to the nearest one-tenth gram while the birds were under three weeks of age and to the nearest gram thereafter. Birds were weighed when the plumage was dry and at approximately the same time each day to prevent the complication of the pronounced daily variations in weight noted in some species (Baldwin and Kendeigh, 1938; Blake, 1956). Weights of adults were recorded in pounds and half-ounces.

Measurements of the exposed culmen and tarsus of juveniles were made with a thin plastic or metal ruler. This method allowed speedy handling of live birds in the field and in the hatchery and yet gave measurements of suitable accuracy for growth studies. Tests with dividers indicated that accuracy to within one-half millimeter for the culmen and one millimeter for the tarsus was attained. The tarsal measurement included the tarsometatarsus and the condyles of the tibiotarsus and the digits.

Scapular and flank pterylae were measured to the nearest one-half centi-

TABLE 1

SIZE OF SAMPLES OF HATCHERY-REARED REDHEADS MEASURED DURING 1952 AND 1953

		Age in Weeks											
		1	2	3	4	5	6	7	8	9	10	12	16
1952	male	7	14	17	17	17	17	16	27	25	21	18	17
1952	female	9	18	21	21	21	20	20	28	28	23	18	13
1953	male	8	8	25	24	24	25	25	24	24	21	—	—
1953	female	15	14	33	32	30	32	31	32	31	30	—	—

meter from the base of the anterior feathers to the tip of the longest posterior feather of the tract. The longest or ninth primary, the middle or sixth secondary, the longest tertiary, and the center tail feathers, were chosen for measurement and their lengths were recorded in millimeters from the base to tip with curved feathers flattened.

Terminology for plumage is that used by Dwight (1900), Forbush (1925), and Witherby *et al.* (1943), and terminology for color is that advised by Palmer and Reilly (1956).

GROWTH AND SEASONAL CHANGES IN BODY WEIGHT

Weights of newly hatched ducklings and increase in weight were reported for a few European anatids by Heinroth (1928:132–229) and Portmann (1950: 525). A more detailed study of the Tufted Duck (*Aythya fuligula*) was made by Veselovsky (1951), who weighed five ducklings every five days from hatching to 55 days of age. Southwick (1953) recorded weights for eight species of ducks reared in the hatchery of the Delta Waterfowl Research Station but data were not taken after six weeks of age and sexes were not differentiated. Elder (1954) presented data on growth of a small number of Redheads used as controls in his study of the oil gland.

Growth of the embryo.—Data were gathered from 23 embryos of three clutches of eggs. Preserved embryos were weighed immediately after being rolled on a blotter. A typical exponential curve characteristic of early growth in body weight (Brody, 1945: 486–492, and others) is apparent (Fig. 1).

Growth of hatchery-reared juveniles.—Three to four grams were lost during the first 24 hours as the feathers dried. Thereafter, body weight increased rapidly (Fig. 2). Males were heavier than females by the second week and remained so throughout life. The greatest increase in weight occurred during the fourth to sixth weeks.

Growth was slightly more rapid in birds reared in 1952 than in 1953,

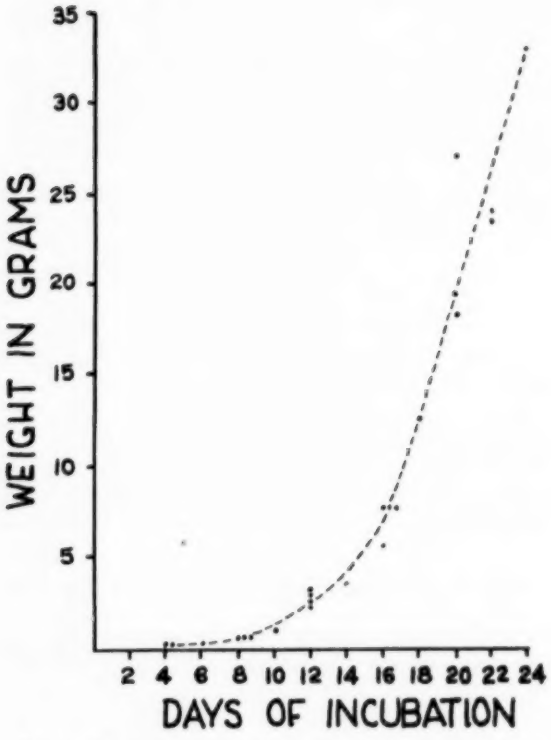


FIG. 1. Scatter diagram of the weights of 23 Redhead embryos.

especially at ages of four to seven weeks. However, during the eighth week of life, weights for the sample in 1952 decreased to the level later reached by birds of the same age in 1953. The larger pen used during the latter year may have permitted more activity and prevented the rapid addition of weight recorded in 1952. Other conditions, such as feeding and pen-cleaning, were identical. The decline in weight observed in 1952 occurred, however, during the period of most rapid growth of the remiges. While the averages for 1953 show no such decline, weights of some individuals did. These data suggest that the period of remex formation is one of great stress. Individuals vary in the amount of weight they lose but few gain during this period. Similar weight losses during fledging in passerines are well known (Edson, 1930). Peters and Müller (1951) and Mrs. Margaret Nice (*in litt.*) have observed such losses in gulls (*Larus* sp.).

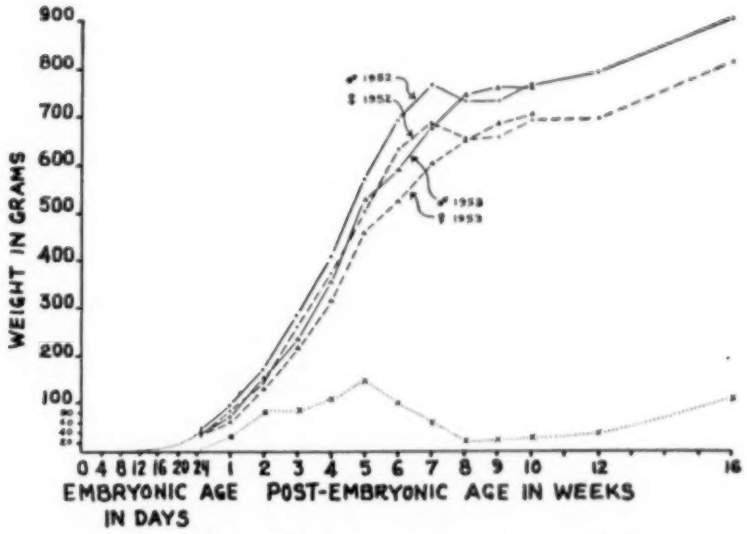


FIG. 2. Average cumulative growth in body weight in hatchery-reared Redheads (upper four curves) and average weekly increment in grams for both sexes and years (lower curve).

In order to determine the effects of handling on growth in weight, a group of 24 hatchery-reared birds was weighed during the first day of life and placed in a pen where they remained undisturbed for eight weeks. A scatter diagram of weights of 19 of these birds and 26 which were handled weekly is shown in Figure 3; there was no obvious effect of handling. A similar comparison was made by Baldwin and Kendeigh (1938); they found no statistical difference between weights of sparrows handled frequently and those trapped only once.

Growth of wild juveniles.—Although embryos in 26 nests were dyed, only six dyed broods were observed and two members of one brood collected. In general, the growth of wild juveniles was quite similar to that of those reared in the hatchery. The two dyed ducklings which were collected differed greatly in size, one (a male, 189 grams) being considerably below and the other (a female, 256 grams) slightly above the hatchery average (Table 2). Additional data were obtained from four birds dyed by Alex Dzubin near Minnedosa, Manitoba; these also are compared with hatchery averages in Table 2. Two weighed slightly more and two less than hatchery average.

Ten males and 17 females were recaptured in banding traps at least once. The increments in body size between periods of capture were compared with the data for hatchery-reared birds (1952), using the initial weight of the

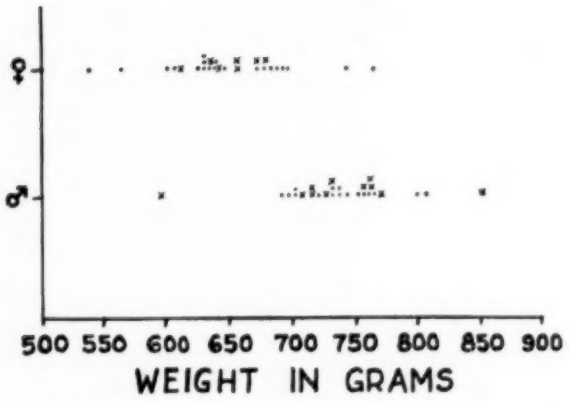


FIG. 3. Scatter diagram of weights of eight-week-old Redheads comparing birds handled each week (•) to those handled only twice (×).

wild bird as a basepoint on the curve for hatchery birds. Wild birds tended to be similar in weight to hatchery birds from two to four weeks and heavier during the eighth and ninth weeks. Because the exact ages of the wild individuals were unknown, the relationship of body weight to culmen length in each group was also compared. Wild birds were slightly heavier than hatchery-reared birds of similar culmen length throughout life. Three of eight wild males and one of five females measured during the fledging period lost weight. Losses were similar in extent to those in hatchery birds and averaged about 50 grams for both groups.

Weights of immature and adult Redheads.—Weights of immature and adult waterfowl have been better studied than those of non-flying juveniles because of the abundance of data obtainable from hunters' bags and banding stations. Notable contributions to our knowledge of duck weights have been made by Leopold (1919, 1921); Phillips (1923–26); Bennett (1938:5–6); Kortright (1943); Bellrose and Hawkins (1947); Mann, Thompson, and Jedlicka (1947); and Nelson and Martin (1953). DuMont and Swenk (1934) and Elder (1946) analyzed the weights of the Canada Goose (*Branta canadensis*) and Elder (1955) presented data on weights of Pink-footed (*Anser arvensis*) and Greylag (*A. anser*) geese.

Weight data from the present study are shown in Table 2 and Figure 4. Only data from wild Redheads are presented because weights of birds housed indoors in winter in Manitoba cannot be considered comparable with those of birds wintering in the southern United States.

TABLE 2

MEASUREMENTS OF SIX KNOWN-AGE REDHEADS COMPARED TO AVERAGES FOR HATCHERY REDHEADS OF EQUIVALENT AGE

	MALES		FEMALES	
	Wild	Hatchery Avg.	Wild	Hatchery Avg.
	(22–23 days)		(22–23 days)	
Weight (grams)	189	277	256	251
Culmen	28[1]	32	31	31
Tarsus	35	47	39	44
Tail	17	21	23	19
	(35 days)		(27 days)	
Weight	495	546	409	325
Culmen	37	39	34	35
Tarsus	50	52	48	48
Tail	37	40	35	31
Scapulars	80	88	55	57
Flank	Complete	Complete	100	108
Primaries	Starting	18	—	—
Secondaries	2	19	—	—
Tertiaries	22	32	5	13
	(47 days)		(32 days)	
Weight	849	733	312	420
Culmen	46	44	32	33
Tarsus	54	54	44	49
Tail	51	53	32	36
Scapulars	135	135	50	70
Flank	Complete	Complete	90	112
Primaries	69	77	—	—
Secondaries	62	65	—	—
Tertiaries	72	77	5	23

[1]All linear measurements are expressed in millimeters.

The average weights of the various age and sex groups observed at Lake Winnipegosis in mid-September (Table 3) showed a pattern similar to that recorded for several other species of ducks by Mann, Thompson and Jedlicka (1947) and Bellrose and Hawkins (1947), and for geese by Elder (1946, 1955): adult males were heaviest, adult females and immature males were similar in weight, and immature females were lightest.

The body weight of the Redhead was greatest prior to migration, as is shown by comparing the average fall weights of Redheads in Manitoba with those in Michigan. Adult birds weighed in Michigan in October averaged seven to eight ounces lighter than Redheads weighed at Lake Winnipegosis, Manitoba, in early October (see Table 3, "post-molt"). These samples are probably from the same population, since many Redheads from Manitoba

pass through Michigan during the fall migration (Robbins, 1949; Brakhage, 1953).

Adequate samples of Redhead weights taken south of Michigan in late fall or winter are not available but presumably the weight lost in fall migra-

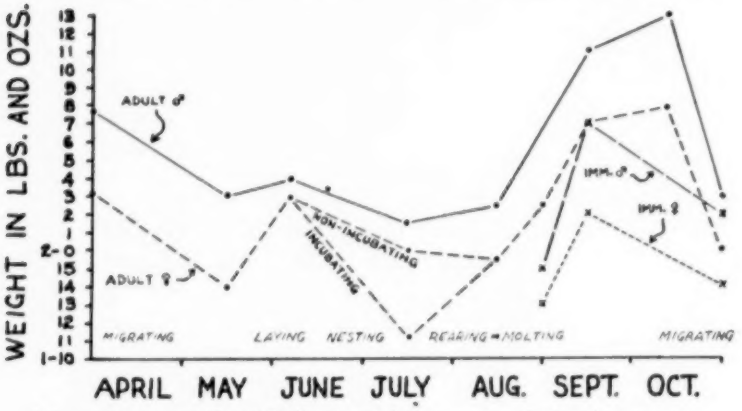


FIG. 4. Average weights of Redheads weighed on or near the breeding grounds.

TABLE 3

SAMPLE SIZE, SOURCE, AND AVERAGE WEIGHTS OF IMMATURE AND ADULT REDHEADS

Age	Area	Source	Stage of Annual Cycle	Average weight Male No.	Male Lbs. Oz.	Female No.	Female Lbs. Oz.
ADULT (Second Summer of Life)							
	Michigan[1]	Banding	Spring Migration	1157	2:7	485	2:3
	Manitoba	Banding	Spring Migration	32	2:3	15	1:14
	Utah	Nest Trap	Parasitic	—	—	40	2:3
	Utah	Nest Trap	Incubating	—	—	6	1:11
	Manitoba	Collected	Courtship	7	2:4	—	—
	Manitoba[2]	Banding	Pre-Molt	33	2:1	71	2:0
	Manitoba	Banding	Early Molt	10	2:2	41	1:15
	Manitoba	Bagged	Post-Molt	51	2:11	19	2:7
	Michigan[1]	Bagged	Fall Migration	40	2:3	52	2:0
IMMATURE (Flying young of the year)							
	Manitoba	Banding	Fall Concentration	148	1:15	172	1:13
	Manitoba	Bagged	Fall Concentration	15	2:7	15	2:2
	Michigan[1]	Bagged	Fall Migration	118	2:2	135	1:14

[1]Data from Michigan Federal Aid Project 45-R.
[2]Data from Peter G. Hanson.

tion is regained during winter and spring. An increase in weight is usual at this time among passerines (Wolfson, 1945). During the spring migration through Michigan (April), Redheads averaged three to four ounces heavier than birds weighed there in the fall (Table 3). Birds captured after arrival in southern Manitoba in late April and May averaged four to five ounces lighter than birds weighed in Michigan in April.

After the spring migration, females gained weight rapidly, as was shown by comparing weights of birds captured in nest traps in Utah with those captured in Manitoba in spring. This difference in weight was not due to differences in average size of Utah and Manitoba birds, for culmen measurements of the two groups were the same. Rather, it was due to intensive feeding following migration and to the growth of ovarian tissue. The ovary, oviduct, and eggs of one female collected during the laying period constituted one-eighth of the body weight, while the reproductive tract of a non-breeding female in August was only 1/2000 of its total weight. Witschi (1956:310) presented similar data for the Starling (*Sturnus vulgaris*). During the laying period, the weight of the female Redhead nearly equals that of the male (Fig. 4).

Redhead females laying parasitically in the nests of other birds gradually declined in weight and continued to decline during incubation (Fig. 5). (No birds were captured during normal laying.) A weight loss during the period of laying and incubating was observed in Ring-necked Pheasants (*Phasianus colchicus*) by Kabat, Thompson, and Kozlik (1950) but Richdale (1947) found that Yellow-eyed Penguins (*Megadyptes antipodes*) lost weight during laying, then regained it during incubation.

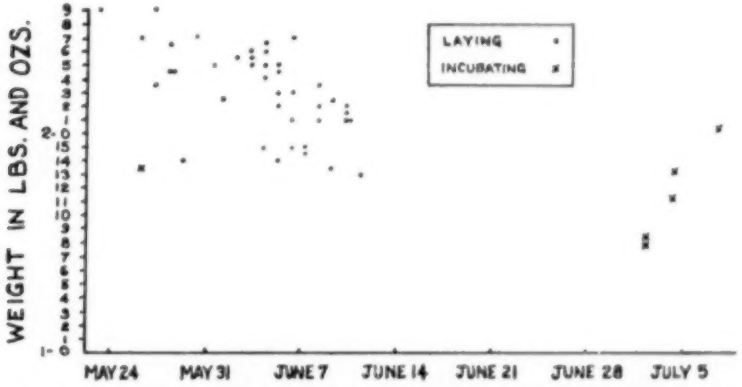


FIG. 5. Scatter diagram of the weights of laying (parasitically) and incubating females captured in Utah in 1955.

Redhead females trapped in July at Lake Winnipegosis averaged three ounces lighter than birds weighed during the laying period in Utah. Some of these birds, examined by Peter Hanson of Ducks Unlimited and myself, had brood patches; others did not and probably were non-breeders. Thus the lowest weight is reached during the period of molt, when environmental temperatures are high. Two flightless females were weighed in the Delta Marsh but their weights were not significantly different from those of other females which were molting only body feathers and which were captured at the same time of the year.

After molting, birds loaf and feed and attain their greatest weight. The heaviest bird recorded was a male taken at Lake Winnipegosis on September 20, 1952, which weighed three pounds, one and one-half ounces.

By mid-September, the average weight of immature birds found in hunters' bags at Lake Winnipegosis was five to eight ounces greater than that of immature birds at Delta during August and early September. Many of the birds shot at Lake Winnipegosis probably were early-hatched young which had flown north from their place of rearing to isolated northern lakes to loaf and feed.

Growth of the Culmen and Tarsus

Data on the growth of the culmen and the tarsus were collected from hatchery-reared birds and from wild juveniles and adults. The growth curves of these parts in hatchery juveniles are shown in Figure 6.

The tarsus grew more rapidly than did the culmen, as it does in most birds (Huggins, 1940). A sex difference in the size of tarsus was apparent by two weeks of age. Because the tarsus reached full size when the bird was in its sixth or seventh week of life, it was not a good criterion of age and was measured only in one season.

The culmen reached nearly full size by the tenth week of life. The table below shows that there was no increase in culmen size after 16 weeks of age.

	16 weeks old		*9 months or older*	
Male	47.6	(16 birds)	47.7	(18 birds)
Female	45.3	(13 birds)	45.0	(95 birds)

Similar data presented by Hanson (1951*a*) for the Canada Goose showed that the culmen was no larger in adults than in birds in their first autumn.

Measurements of culmen and tarsus of known-age, dyed, wild juveniles are compared to those of hatchery-reared birds in Table 1 and show close agreement. However, when data secured from wild birds which were marked and recaptured were compared with hatchery data from hatchery-reared birds, the latter seemed to have grown faster than wild birds. This may be a result of small sample size.

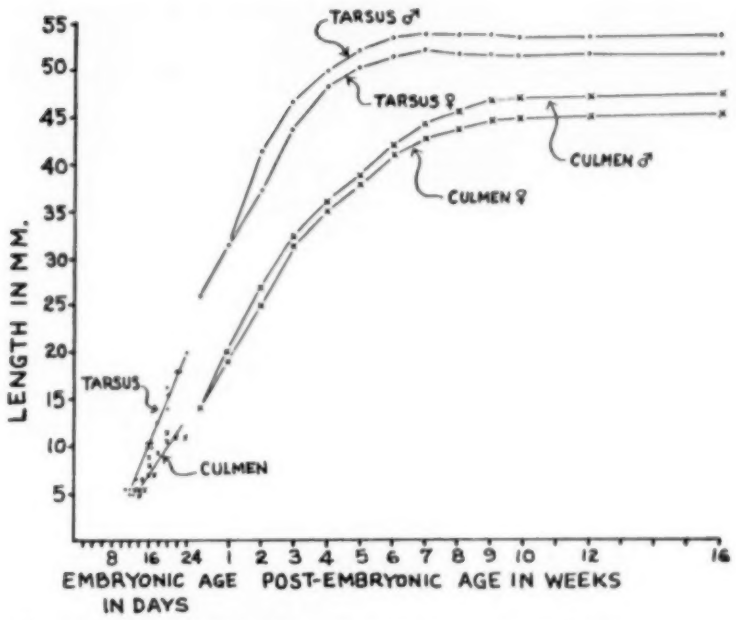


FIG. 6. Cumulative growth in size of culmen and tarsus in juvenal Redheads, and scatter diagram of measurements of embryos.

A comparison of culmen measurements of adult females from Manitoba and Utah showed no significant difference in these populations: 46 females from Utah averaged 44.9 millimeters and 49 from Manitoba averaged 45.1 millimeters. Little geographic variation in size is to be expected because of the mingling and pairing of birds from different areas on wintering grounds, a factor which limits subspeciation in many species of ducks, according to Mayr (1942:241–242).

DEVELOPMENT OF NATAL AND JUVENAL PLUMAGES

Bent (1923; 1925) was one of the earliest workers to report observations on sequence of feathering in juvenal waterfowl. He included data on Mallard (*Anas platyrhynchos*), American Widgeon (*Anas americana*), Cinnamon Teal (*Anas cyanoptera*) Pintail (*Anas acuta*), and the Canvasback (*Aythya valisineria*). Less extensive notes on other species, and comparisons between species, such as the Redhead and Canvasback, also were presented. While his descriptions were incomplete, general patterns were established.

FIG. 7. Redhead embryos ranging from four to 22 days incubation, photographed at two-day intervals.

More detailed information has since been published for the Canvasback (Hochbaum, 1944:103); Wood Duck, *Aix sponsa*, (Hanson, 1951*b*); Tufted Duck (Veselovsky, 1951); and Grey Duck, *Anas superciliosa*, (Cunningham and Welch, 1955). Comparative studies of several species have been made by Heinroth (1928:132–229) and Southwick (1953).

Natal plumage.—Figure 7 shows Redhead embryos at two-day intervals from four to 22 days of incubation. Hatching occurs at 24 to 28 days, according to Hochbaum (1944:90), Peter Ward (*pers. comm.*), and my own observations.

The rectrices appear at 12 days, followed by the feathers of the spinal and femoral pterylae at 14 days. The capital feathers and remiges are evident at 16 days and the embryo is completely feathered at 20 days of age.

The appearance of the feathers plus other morphological features, such as size, proportion of head to trunk, and development of limbs and bill, serve as excellent criteria for age determination of embryos. These characteristics are apparent in Figure 7.

Upon hatching, the Redhead duckling is the lightest in color of any diving duck (see Kortright, 1943: Plate 34). Considerable variation in color occurs, however; some ducklings are cream and brownish-olive while others are nearly as dark as Canvasbacks. Leg and bill color usually vary with the

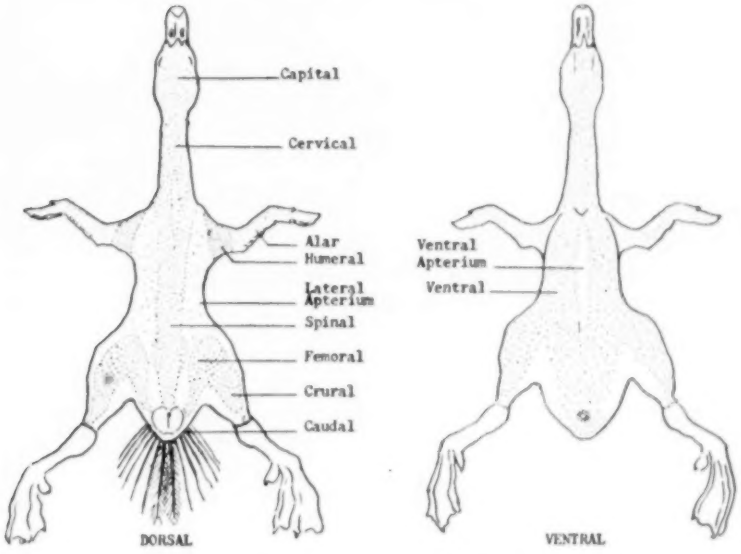


FIG. 8. Pterylography of a downy Redhead.

plumage. Color variation is not widespread, however, and is not due to differences in sexes as reported in the Tufted Duck (Veselovsky, 1951).

Characters for distinguishing Redhead ducklings from those of the Canvasback and Ring-necked Duck (*Aythya collaris*), which they resemble, have been presented by Brooks (1903), Phillips (1925: Plate 59), Todd (1936), Kortright (1943: Plate 34), and Hochbaum (1944:101).

The pterylography of a downy Redhead is shown in Figure 8. In size and position of the apteria of ducklings, the Redhead did not differ noticeably from the Pintail and Mallard.

Color of the natal down gradually fades in the wild. This fading probably varies with weather conditions. Most of the bright color is lost within five to eight days in the wild but remains several weeks in the sheltered, hatchery-reared birds.

Juvenal plumage.—Figure 9 illustrated the sequence of feathering in the juvenal Redhead. These drawings also serve to show the sequence of feathering in the Canvasback, which grows at the same rate as the Redhead (Hochbaum 1944:108). Figure 9 is designed to permit determination of the age of ducklings in the field. The correspondence between the age of the ducklings in weeks and the age classifications commonly used by waterfowl

survey personnel (Southwick, 1953; Gollop and Marshall, 1954) is as follows:

Age in weeks	Age classification
1	I a
2	I b
3	I c
4	II a
5	II b
6	II c
7	III a
8	III b

The first feathers of the juvenal plumage are those of the tail, which push out the natal tail feathers at 12 to 14 days after hatching. The natal feathers are continuous with the juvenal feathers and cling to the latter until the teleoptile is partly vaned (Jones, 1907; Beebe and Crandall, 1914; Ewart, 1921), dropping off in wild birds at three to five weeks of age and forming the notched tail feathers useful in determining the age of ducks. The juvenal rectrices are not visible in the field until the birds are nearly four weeks old. Cumulative growth of the tail, as well as the primaries and scapulars, is plotted in Figure 10.

Dyeing ducklings in the eggs was an especially useful technique for rendering conspicuous the changes in down feathering. Juvenal body down develops between the bases of the natal down feathers at two weeks of age. This juvenal down was observed by Veselovsky (1951) in the Tufted Duck. It is not complete in the Tufted Duck until 30 days of age but it completely covers the Redhead by 20 to 25 days. In the Redheard, this down is pale gray on the underparts and medium gray on the upper parts, giving the pattern of the back more contrast than is evident in the natal down.

At two and one-half to three weeks, contour feathers of the auricular region and the flanks and scapulars develop, but these are not usually visible in the wild until the bird is nearly four weeks old. Hatchery birds have a more downy appearance than do wild birds of the same age because down breaks off the juvenal feather earlier in the wild.

At four weeks, the head and back are distinctively marked by the patches of new feathers but most of the upper parts are still downy. The underparts are mostly feathered, only the upper breast and legs remaining downy. The under and upper tail coverts are present, the vanes of the tertiaries are breaking from their sheaths, and the quills of the secondary and primary feathers are breaking through the skin.

By five weeks of age, juveniles of the Redhead are almost completely feathered, with down remaining only on the rump, back, and the base of the neck. The tertiaries and greater, median, and lesser secondary coverts are well developed. The secondaries are present but the vanes are hidden by the overlapping coverts. The primaries are present only as quills.

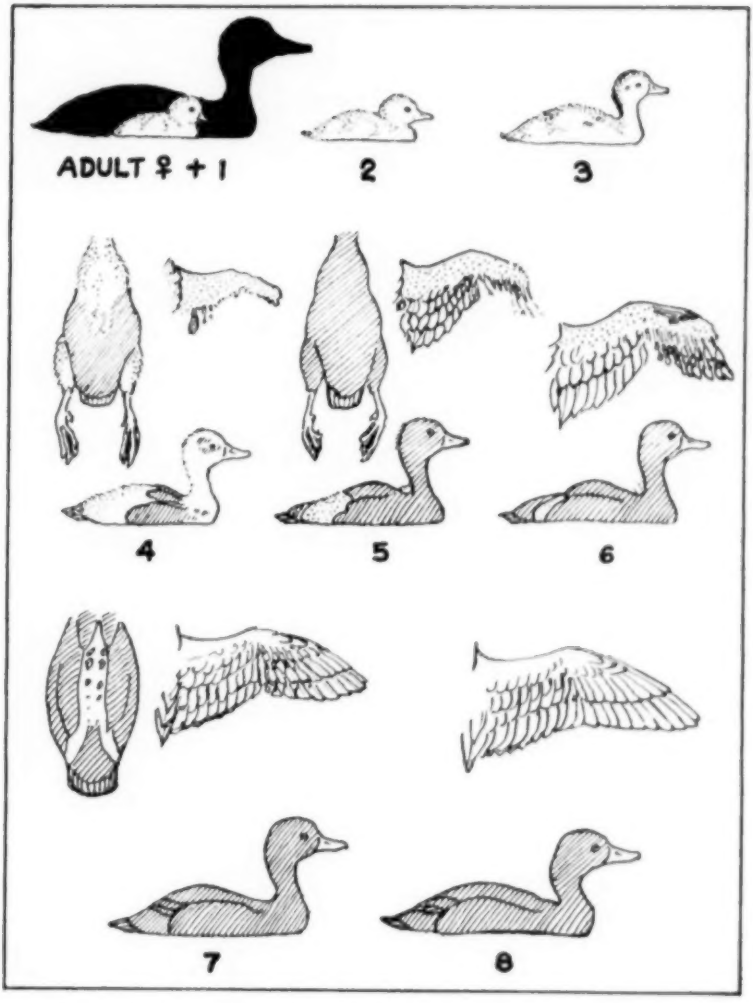


FIG. 9. Sequence of feathering in the Redhead from one to eight weeks old.

At five or six weeks of age, the scapulars and interscapulars of males show delicate white vermiculations or frosting. This is a valuable characteristic for sexing birds and has been used for several years by A. S. Hawkins

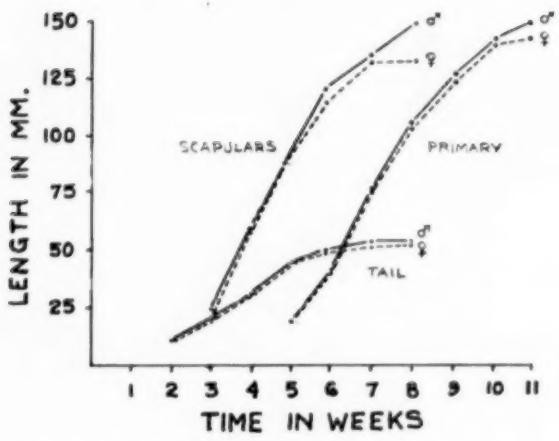


FIG. 10. Cumulative growth of juvenal rectrices, scapulars and primaries.

when banding Redheads. Occasionally females are found with white flecking in this region but only one case was observed which might have been confused with the vermiculations of the male.

Down still remains on the back at six weeks but the rump is well feathered, forming an inverted "V" of feathers pointing toward the head. The primaries are breaking from the tips of the long, bluish quills.

In the seven-week-old Redhead, feathering of the back occurs in two rows from the rump to the interscapular region. The remaining down is covered, however, by the scapulars which now extend beyond their coverts. The white tips of the secondaries are visible when the wing is held loosely in place or flapped but otherwise they are hidden by the scapulars and tertiaries. The sheaths of the primaries and greater primary coverts are still conspicuous.

By eight weeks of age, Redheads are usually completely feathered. A trace of down may remain on the backs of retarded birds. The wing appears complete but the bases of the quills are soft and the feathers not quite fully grown. In advanced birds, as many as half of the primaries may be hardened. Usually the calami of all the secondaries are hard and translucent by this time, as are those of the tertiaries.

Hardening of primaries and the time of flight.—Hochbaum (1944:103) stressed the importance of the age at time of flight to the survival of juvenal waterfowl and presented data for 11 species of hatchery-reared ducks. A summary of published observations of the age at which flight is attained in

TABLE 4

AGE AT WHICH FLIGHT IS ATTAINED BY SOME NORTH AMERICAN DUCKS

Species	Age in Days	Authority
DIVING DUCKS		
Redhead	56	Evans, Hawkins, and Marshall, 1952
Redhead	56–63	Williams and Nelson, 1943MS
Redhead	56–73	Present study
Redhead	63	Dzubin, 1952
Redhead	63–70	Phillips, 1925: 175
Redhead	63–77	Hochbaum, 1944: 108
Redhead	70–84	Low, 1945
Canvasback	54	Evans, *et al.*, 1952
Canvasback	58–65	Dzubin, 1952
Canvasback	63–77	Hochbaum, 1944: 108
Canvasback	70–84	Bent, 1923: 194
Lesser Scaup[1]	56–73	Hochbaum, 1944: 108
White-Winged Scoter[2]	63–77	Hochbaum, 1944: 108
Ruddy Duck[3]	49	Stresemann, 1940
Ruddy Duck	52–66	Hochbaum, 1944: 108
Goldeneye[4]	56	Stresemann, 1940
Goldeneye	62	Millais, 1913
DABBLING DUCKS		
Mallard	49–60	Hochbaum, 1944: 108
Mallard	56	Stresemann, 1940
Mallard	56–70	Ewart, 1921
Gadwall[5]	49–63	Hochbaum, 1944: 108
American Widgeon	45–58	Hochbaum, 1944: 108
American Widgeon	47	Evans, *et al.*, 1952
Pintail	38–52	Hochbaum, 1944: 108
Pintail	49	Stresemann, 1940
Pintail	42	Dzubin, 1952
Blue-winged Teal[6]	38–49	Hochbaum, 1944: 108
Blue-winged Teal	40–47	Dzubin, 1952
Blue-winged Teal	42	Bennett, 1938: 55
Shoveller[7]	39	Dzubin, 1952MS
Shoveller	52–60	Hochbaum, 1944: 108

[1]Aythya affinis
[2]Melanitta deglandi
[3]Oxyura jamaicensis
[4]Bucephala clangula
[5]Anas strepera
[6]Anas discors
[7]Anas clypeata

ducks is shown in Table 4. In general, the divers require longer to reach the flying stage than do the dabblers.

Growth and feathering of geese is rapid. Blue and Snow geese (*Anser caerulescens*) have been reported flying at slightly more than four weeks on Baffin Island by Soper (1930:53) and at five and one-half to six weeks

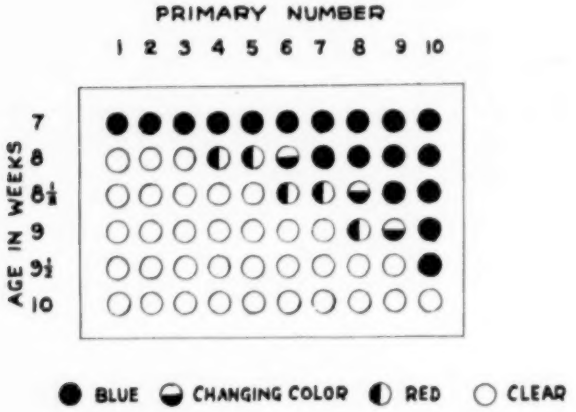


FIG. 11. Color changes and hardening of the rachis of primary flight feathers in juvenal Redheads.

on Southhampton Island by Cooch (1953). The somewhat larger Canada Goose has been recorded as flying at 10 to 11 weeks by Heinroth (1928:178) and seven to eight weeks by Moffitt (1931). Balham (1954MS) observed that nine weeks were required to reach the flying stage but that the time of first flight was influenced by family and flock behavior.

It is difficult to determine the time of first flight of individual birds, either in the hatchery or in the wild. Hochbaum's (1944:108) observations on hatchery birds were based on records of individuals over a period of years but this method was not satisfactory for observing large samples of waterfowl. Also, it is doubtful that the stimulus to fly is as great in an enclosure as it is in the wild, and thus records from captivity may be biased. Therefore, the age at time of flight of large groups of captive birds was estimated by observing the hardening of the shafts of the flight feathers. This occurs as follows: The sheathed feathers ("blood quills") are soft and bluish. The sheath cracks off from the tip to the base and the vane unfolds. When the vane is nearly free, the rachis becomes translucent. The color of the rachis changes from a milky-blue to purple or mottled blue and red and then to pure red. Finally the rachis becomes white and then translucent and hard. The hardening of the remiges follows the sequence of their growth, progressing from proximal to distal remex. A typical pattern is shown in Figure 11.

Field observations showed that flight of wild birds was possible before all primaries had reached the clear stage. Since each proximal remex overlaps each succeeding distal remex, the hardened primaries reinforce each

of the soft primaries. In addition, the ratio of body weight to wing area is less in the juvenile than in the adult. Juveniles of 10 to 12 weeks of age with all but two primaries clipped from both wings are capable of short flights. Hatchery-reared birds which were released in the wild flew well with three to five soft primaries and wild-trapped birds with an equal number of soft primaries were able to fly when tossed into the air. This by no means indicates that birds of that age are masters of their wings; several weeks of experience are necessary before the birds are good fliers. However, it may be concluded that Redheads are able to fly when five primaries are clear and hard. The information presented in Table 5 is drawn from observations of hatchery-reared Redheads and shows the age at time of flight as indicated by the presence of five hardened primaries.

TABLE 5

AGE OF HATCHERY REDHEADS AT TIME OF FIRST FLIGHT AS INDICATED BY THE HARDENING OF THE PRIMARIES

(Data for 1952 and 1953 combined)

Age	Number of Birds
Eight weeks	2
Eight and one-half weeks	29
Nine weeks	41
Nine and one-half weeks	13
Ten weeks	7
Ten and one-half weeks	1
TOTAL	93

POST-JUVENAL MOLTS AND PLUMAGES

Post-juvenal molt and first winter plumage in the male.—Feathers of the first winter plumage make their appearance before the juvenal primaries are fully hardened. Many males have brownish-red feathers in the lores and cheeks at eight weeks of age; these are present in all males at nine weeks. At 12 to 13 weeks conspicuously vermiculated scapular and flank feathers appear (see Color Plate). At 14 weeks, the male's head is more chestnut than buffy brown, about one-fifth of the flank and scapular feathers are of the winter plumage, and a ring of black feathers encircles the neck. New feathers are evident in the breast and belly. At 16 weeks, the breast is conspicuously mottled with black and the head is usually chestnut but varies from pale fuscous to blackish brown in different individuals. The first winter plumage is nearly full by January or February when the birds are six and one-half to eight months old, as was noted also by Bent (1923:80) and Phillips (1925:

FIG. 12. Adult (left) and yearling Redhead males, showing greater amount of white in the breast in the first winter plumage.

64). A few males are still molting upon arrival on the breeding grounds in April and many retain juvenal plumage of the back and venter until their first post-nuptial molt. Dwight (1914) noted spring molt of yearling male Scoters (*Melanitta* spp.) and recognized that it might be delayed post-juvenal molt. Smalley (1915) believed that spring molt in yearling male ducks was merely delayed post-juvenal molt. The entire juvenal plumage of the wing is retained through the first winter but the juvenal tail feathers are shed at three and one-half to seven months and replaced with new, pointed dark gray feathers. No regular sequence of loss is apparent but tail feathers are replaced as they are lost.

The first winter plumage rarely has the brilliance of later winter plumages, as was noted in the Pochard (*Aythya ferina*) by Millais (1913:15). The light magenta iridescence of the head and the vermiculated feathers of the flank and scapulars are of more subdued coloration than in later years. The juvenal wing is much less frosted with white than is that of the adult, and the white frosting on the greater primary and secondary coverts, median primary coverts, and inner alula feathers is lacking. The line of demarcation between the black breast and white belly is also less clear-cut (Fig. 12).

Post-juvenal molt and first winter plumage in the female.—Color changes in the female are less conspicuous than those in the male because the first winter plumage in females closely resembles that of the juveniles. Plumage changes were observed by parting feathers and clipping them to watch their replacement. Molt and development of the female's first winter plumage is

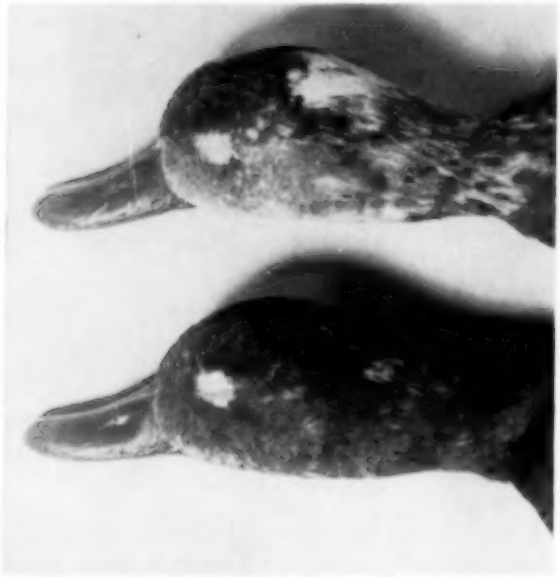


FIG. 13. Variation in abundance of white feathers on the heads of adult female Redheads.

identical with that of the male.

Distinguishing yearling from adult females is difficult because the adult and juvenal wing feathers are identical. The undertail coverts of yearlings in first winter plumage usually show a pattern of speckled buffy brown on a white background, while those of adults have brownish-olive patches on white. Adults tend to have more frosting of white on the scapulars and usually have white feathers on the back of the head (Fig. 13).

These white head feathers are of particular interest; their numbers seem to increase with age as in hawks (Brooks, 1920), but the most conspicuous change appears to occur during the second fall and winter. Nearly all wild hens have a few white feathers, but captive females rarely do. The location of these feathers suggests that they may develop as a result of damage to the feather follicle when the male pinches the female's head during copulation. However, attempts to induct formation of white feathers in four females by pinching the skin with pliers were unsuccessful.

White head feathers occur less frequently and less abundantly in other members of the genus *Aythya* in North America and in the European Pochard.

Spring molt.—Yearling, as well as older females, undergo a partial molt

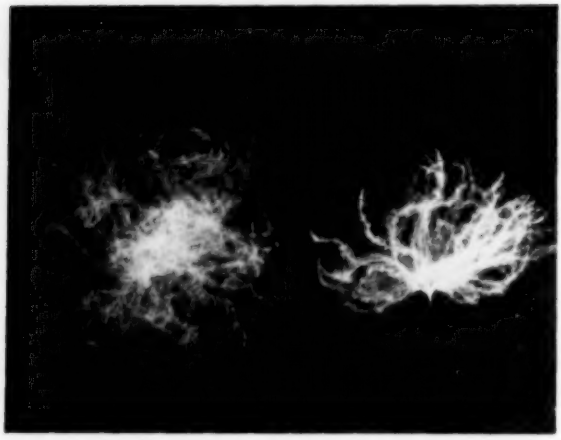


FIG. 14. Nest down (left) and winter down feathers of the Redhead.

in late April, May, or early June, just prior to breeding. As a result of this molt, the crown, cheeks, neck, side of the lower neck, flanks, and occasionally scapulars, develop a deep tawny plumage (see Color Plate). Similar feather replacement was noted by Jackson (1915), Smalley (1915), and Schiöler (1921) in several dabbling ducks and by Jackson (1915) and Witherby, *et al.*, (1943:290) in European members of the genus *Aythya*. Jackson also noted that a special nest down was acquired during the spring molt which was "much longer and coarser than the ordinary down." Measurements of 25 down feathers from six Redhead nests and 25 down feathers from various parts of an adult Redhead female collected in October showed that nest down averaged 22 mm. in length while the autumn down averaged 20.1 mm. Of greater significance was the fact that 100 barbules of nest down averaged twice as long as a like number of barbules of autumn down; it is this difference which causes the more plumose appearance of nest down (Fig. 14). The barbules of down feathers from an immature female in fall were likewise very short. The increased growth of breast down in spring may be a result of higher estrogen levels during the breeding period, a causal relationship demonstrated for the Domestic Chicken (*Gallus gallus*) by Juhn, Faulkner, and Gustavson (1931). Down feathers acquired in spring are not conspicuously darker than those acquired at other times of the year, as was noted in dabbling ducks and some diving ducks by Jackson (1915) and Bowles (1917).

Plumage of the incubating female.—Six females trapped during incubation

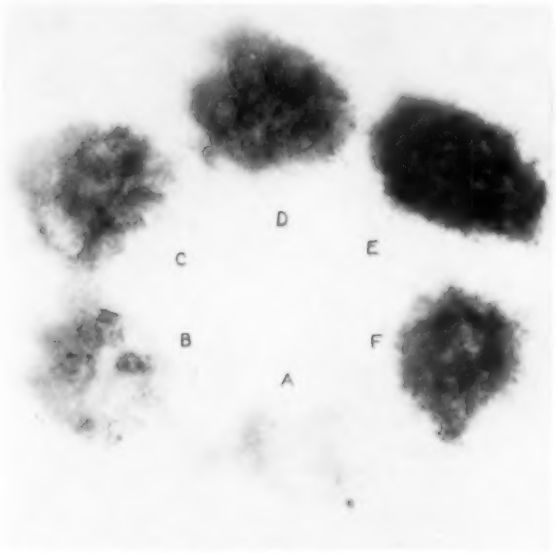


FIG. 15. Variation in color of Redhead nest down feathers (A through D) compared to Canvasback nest down (E) and a nest down feather of a Redhead × Canvasback hybrid (F).

showed no molt or replacement of contour feathers. This was also the case for six Canvasback females captured on the nest. However, some down is continually being replaced. This down has been reported as nearly pure white (Bent, 1925; Hochbaum, 1944; Broley, 1950), but much variation occurs. Individual females had down feathers which varied in color from white to medium gray (Fig. 15). About half of all birds examined had mixtures of white and gray.

Incubation patches have not been reported for members of the Anatidae (Bailey, 1952), but Stresemann (1934:392) wrote that long down develops and is plucked by the female for her nest. This down is probably loosened by physiological changes in the brood patch, such as those demonstrated in sparrows and gulls by Bailey (1952). Preening may then loosen the feathers but I observed no direct plucking by hens. Sufficient down is lost from the abdomen to create an area bare of down (Fig. 16). This condition was apparent in a female captured after nine days of incubation but it probably could be found earlier because most down is added to the nest before incubation begins. In Redheads, the down-free patch may be two to four inches wide and four to five inches long but some Redheads and all

FIG. 16. Incubating Redhead female with ventral feathers parted to show absence of down on abdomen.

Canvasbacks observed were devoid of most down over the entire breast and abdomen.

First-year eclipse and second winter plumage of the male.—The first winter plumage of yearling males becomes dull by late June. In late June or early July, when the bird is about one year old, the post-nuptial molt results in the development of the first eclipse plumage (see Color Plate). Molt and replacement are complete in most birds. The eclipse plumage of the male Redhead more closely resembles its winter plumage than is the case of the eclipse plumage of male dabbling ducks (see Kortright, 1943). Male Redheads become flightless during July and August and renew their body and wing feathers in August and September. The remiges and rectrices are shed and renewed once while the body feathers are molted and renewed twice. I have no evidence indicating that the tail is molted twice as Kortright (1943: 22) states is true of the Mallard. By late September or early October, the males are often in their second winter plumage.

The sequence of molt is as follows: The rectrices are lost irregularly and replaced as they are lost. Thus some feathers are fully grown before others have been shed. Their molt precedes that of the wing and proceeds concurrently with the body molt. The remiges are not lost until the head, neck,

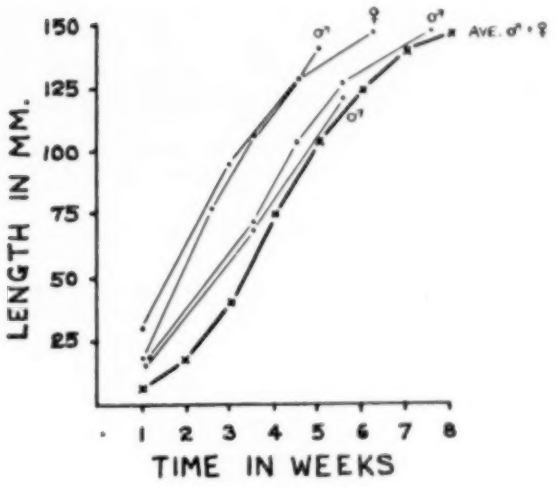


FIG. 17. Growth of the ninth primary in four adult Redheads (fine lines) compared to the average for juveniles (heavy line).

and breast are in nearly full plumage and the flank feathers are being renewed. No definite sequence of molt of the remiges was apparent but all were lost in less than a week. They are renewed in sequence, following the pattern of remige growth in the juvenile—proximal before distal. Remiges of the adult appear to grow at a slightly faster rate than in the juvenile (Fig. 17) and are fully hardened in five to six weeks. The under-wing lining and the axillaries are usually held until the remiges are half grown. The wing coverts are the last to be renewed, the median secondary and central marginal coverts being retained until nearly all other coverts have been replaced. The male wing is then fully adult.

Irregularity of the line of demarcation between black breast and white belly is apparent in the eclipse plumage of yearling birds as it is in the first winter plumage.

Males which desert their females in June in the Delta Marshes fly northward to feeding areas of lakes in northern Manitoba and molt in late July and August. Because some time elapses between the desertion of the female in June and July and inception of the molt and because of the importance of decreasing day-length in regulating molt (Lesher and Kendeigh, 1941), it might be expected that the wing molt would occur at the same time each year. However, there is evidence that the time of molt in the Redhead male is also influenced by seasonal weather patterns and related breeding phe-

nology. This was indicated by the condition of the primaries of adult males shot in Lake Winnipegosis and examined in hunters' bags during 1952, 1953, and 1954. In 1952, 29 per cent of 56 adult males had some soft primaries. The 1953 nesting season was about 10 days later and this was reflected in the molt of the bagged males; 60 per cent of 113 adult males had soft primaries. In addition, the males had much of their eclipse plumage remaining, while most were in nearly full winter plumage in 1952. Nesting was further delayed 10 days in 1954 but the hunting season also was set back 10 days over the previous two years. Nevertheless, an examination of adult males by Game Guardian Sigurdur Oliver of the Manitoba Game and Fisheries Department showed that 68 per cent of 31 males had some soft primaries.

Summer molt of the female.—The female undergoes a single complete molt in late summer that results in the second winter or adult plumage. In Manitoba, females with broods are often in full body molt in August. I have never seen a flightless female with a brood. The nuptial plumage is very faded and worn (see Color Plate) and the new plumage is dark brown. The sequence of the molt occurs as in the male, although perhaps not with the same rapidity. It is usually not complete until October. By dyeing captive birds in midwinter, after the full plumage was acquired, it was found that no main contour feathers were renewed during the winter. Some small feathers, such as those of the head and down feathers, seem to be renewed almost continuously. However, there is no evidence that a double molt occurs in the female in fall as it does in the male.

Adult or second winter plumages.—The adult plumages are shown in the Color Plate and have been described adequately elsewhere. There is little further change once the bird has reached its second winter but the brilliance and distinctness of the winter plumage often improves with age.

The normal cycle of development and sequence of plumages of the Redhead is summarized in Figure 18. The difference between the sexes in the sequence of molt is of special interest. Witherby *et al.* (1943:290) found similar sequences of molt in the European Pochard and suggested that the plumage acquired by females in spring corresponds with the male's eclipse plumage which is acquired in August. Since this spring plumage is a breeding plumage, it seems more likely that it corresponds to the breeding plumage of the male, which is acquired in September and October following the post-eclipse molt. The non-breeding (=winter) plumage of the female is acquired in late summer and is retained until spring, as in passerines. The non-breeding (=eclipse) plumage of the male is retained only about a month, after which the breeding plumage (which is worn throughout the winter) develops.

The sequence of molting in the male Redhead results in avoidance of molting during migration and in winter and yet the male is in full breeding

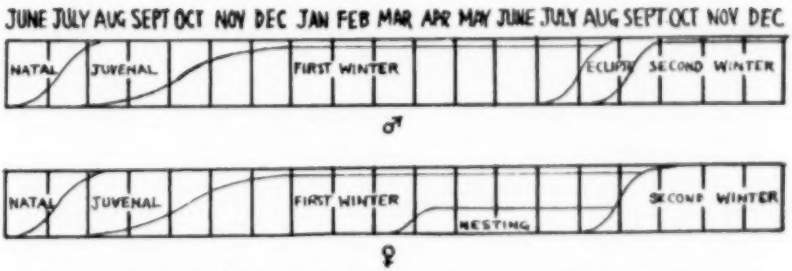


FIG. 18. Sequences of plumages in male (upper) and female Redheads from hatching until the acquisition of the second winter plumage. Height of the curve shows the approximate percentage of the plumage replaced.

plumage when courtship begins on the wintering areas. The evolution and retention of a different sequence in the female is perhaps related to the lesser importance of plumage during courtship and the value of protective coloration and a suitable supply of nest down. Stresemann's (1940) descriptions show that a sequence similar to that of the female Redhead occurs in both sexes of the Ruddy Duck (*Oxyura jamaicensis*) and in the hen Pintail, but the Pintail drake and Mallards and Goldeneyes (*Bucephala clangula*) of both sexes molt in a sequence similar to that described above for the Redhead male.

Development of and Seasonal Changes in Bill and Eye Color

Sexual differences in eye color are apparent as early as eight to 10 weeks: the iris of the male is a dull straw yellow and that of the female is dull yellow-lime with a brownish center. At 12 to 16 weeks of age, the eye of the male is brighter and that of the female is more brown than greenish. These colors brighten throughout the winter and by April the male's iris is yellow and the female's is sepia.

While wearing eclipse plumage, the male's iris becomes a dull yellow-orange but there is no conspicuous change in that of the female at this season.

No distinct difference in leg color is apparent in members of the genus *Aythya* during the eclipse plumage, such as was found in the Black Duck, *Anas rubripes*, (Shortt, 1943) and other members of the genus *Anas*. Legs of adults tend to be less greenish and a darker gray than those of juveniles.

Sex differences in bill color also become apparent at eight to 10 weeks. The tip darkens and a vague, transverse white line forms behind the tip. This is more conspicuous in males than in females but not until the following spring does it approach the distinct condition found in the adults. In the male the remainder of the bill gradually lightens and becomes a pale cobalt. During the eclipse period it loses its bluish coloration and becomes blackish

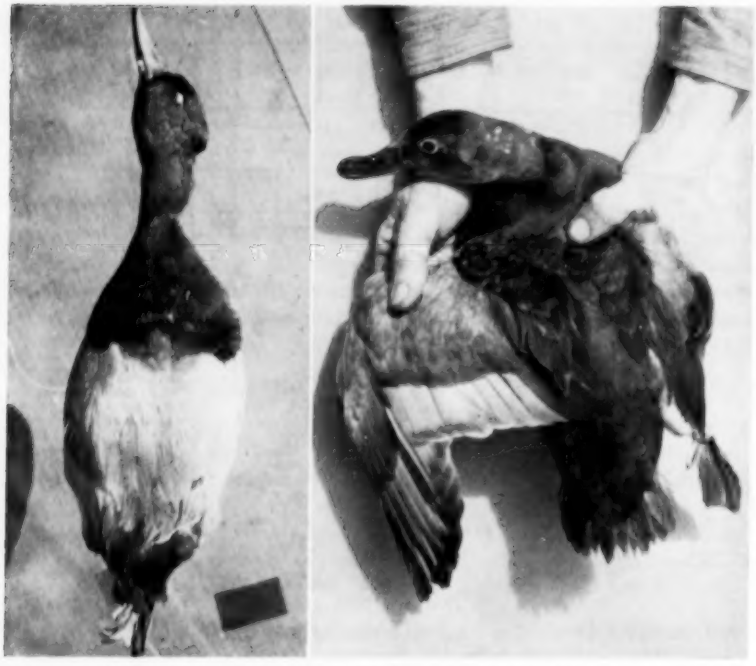


FIG. 19. Male (left) and female Redhead × Canvasback hybrids. Note the profile in each and the white feathers of the nape of the female.

gray like that of the female in spring (see Color Plate). The coloration of the male's bill tends to become brighter with age. The female's bill darkens until it is nearly black during late summer.

PLUMAGES OF SOME HYBRIDS

Cockrum (1952) reported that the Redhead has been known to hybridize in the wild with the Wood Duck, Pintail, and Ring-necked Duck, and McIlhenny (1937) described a bird which apparently was a cross between the Redhead and Canvasback.

Two hybrids were observed in the present study. A wild Redhead male was crossed with a captive Canvasback hen. The offspring were one female and five males but only the female survived beyond the age of one year. Both the male and the female hybrids were intermediate in morphological and plumage characters between the Redhead and Canvasback, resembling

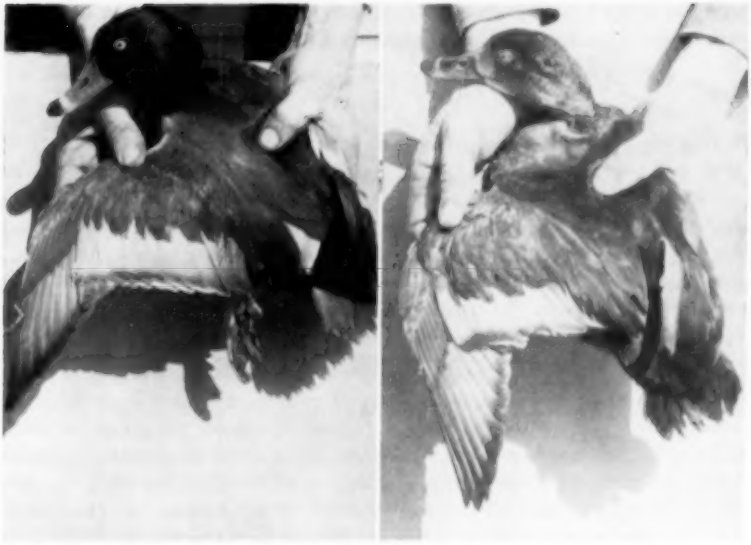


FIG. 20. Male (left) and female Redhead × Ring-necked Duck hybrids. See text for discussion of characters.

the Common Pochard very closely. These hybrids are shown in Figure 19. Of special interest is the white on the head of the female; normally, the Canvasback female has few, if any, white head feathers during adulthood. As is characteristic of the Canvasback, however, the hybrid hen showed much vermiculation on the wing coverts and the scapulars. The first generation hybrid female mated with a Redhead and produced fertile eggs, the young of which resembled downy Redheads. The bills of the second generation hybrids were slightly deformed.

The sexes of the parents of the Redhead–Ring-neck hybrids shown in Figure 20 were unknown. Very apparent in these hybrids were the intermediate body size and voice. The feathers at the base of the culmen were more "V" shaped as in the Redhead rather than "U" shaped as in the Ring-neck (Todd, 1936) and the white ring on the bill was more prominent than in the Redhead. The male's head was brownish black and both the head and the neck had a tinge of chestnut plus a violet iridescence. The back was delicately vermiculated and much darker in color than that of a Redhead. No iridescence was apparent on the secondary coverts of the male as is found in the Ring-neck. The female's plumage contained more gray than is normal for the Redhead, and the lores and eye-ring were whitish as in the Ring-neck. The courtship

behavior of the hybrid male was more like that of the Redhead than the Ring-neck—very aggressive and with intensive calling and displaying.

Summary

This paper describes the growth and sequence of plumages of young Redhead ducks and the weight changes and sequence of molts and plumages in adults. Information was derived from young Redheads reared at the Delta Waterfowl Research Station, Manitoba, wild juveniles which were dyed while in the egg or which were trapped, banded, and later recaptured. For adults, information was obtained from hatchery birds which were kept captive for as long as five years, from wild females trapped on the nest, from birds captured in banding traps, and from others killed by hunters.

Cumulative curves of growth in weight of embryos and juveniles are presented and show typical sigmoid form. However, a decline in weight was noted during the period of remige formation. Males were heavier than females by the second week and remained so throughout life. Hatchery-reared birds tended to be lighter in weight than wild birds of the same age but other development was comparable. Growth of the culmen and tarsus was also recorded and showed a steadier progression than did weights.

Weights of Redheads were influenced by age, sex, and season. In the fall, adult males were heaviest, adult females and immature males were similar in weight, and immature females were lightest. Birds of both sexes lost weight during migration and molt, and females lost during laying and incubation. Minimum weights were reached during the summer molt and maximum weights during the post-molt and pre-migration periods in fall.

Pterylography and sequences in growth of feathers in juveniles are described. A diagram of feather development at weekly intervals, designed to aid in determining age of juveniles in the field, is presented.

Ability to fly was attained at eight and one-half to nine weeks, although the primaries were not fully hardened until the juveniles were 10 to 11 weeks of age. Development of the first winter plumage started before the young were able to fly and was usually complete by mid-winter. A few birds were still molting in early spring after arrival on the breeding grounds.

Sequence of molt was different in the two sexes. The female attained a breeding plumage by a partial molt in spring and a winter plumage by a complete molt in late summer. The adult male, however, had no spring molt but acquired an eclipse (=winter) plumage in late summer and a breeding plumage in fall.

Some features of the plumages of hybrids between Redhead and Canvasback and Redhead and Ring-necked Duck are described.

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Missouri Cooperative Wildlife Research Unit, University of Missouri, Columbia, Missouri, July 12, 1956

THE RELATIVE MAGNITUDE OF THE TRANS-GULF AND CIRCUM-GULF SPRING MIGRATIONS

BY HENRY M. STEVENSON

RECENT studies of the spring migration of birds, like earlier investigations, indicate the existence of routes both around and across the Gulf of Mexico. The present study attempts to determine which species (if any) utilize one of these routes to the exclusion of the other, which species predominate on each route, and which use the two routes about equally. Evidence pertinent to the problem comes from three sources: (1) direct observation of migrating birds; (2) the comparative abundance of birds around the Gulf in spring; (3) the sequence of spring migration arrival dates. Telescopic observations of birds crossing the face of the moon, since they do not distinguish between species, are not useful in this study.

ACKNOWLEDGMENTS

Some of my field work in this study was supported by research grants from Florida State University. Permission to use the copyrighted maps was kindly granted by the McKinley Publishing Company. Constructive criticism of the manuscript was offered by George M. Sutton and Keith L. Dixon. Technical advice was generously given by William A. Lunk; and Jack Veghte and Miss Barbara Wyatt, of Florida State University, aided in the preparation of certain maps. Without the assistance of scores of contributors of field data such a paper as this could never have been written. These are listed under the state or region in which their major contribution was made, although some submitted data from two or more states: *Alabama:* Thomas Z. Atkeson, Benjamin and Sylvia Berkowitz, David Hulse, Thomas A. Imhof, F. W. McCormack, Mrs. D. O. Wright; *Arkansas:* M. Brooke Meanley; *Florida:* William G. Atwater, H. I. Cone, William H. Cross, Mr. and Mrs. Allan D. Cruickshank, Mr. and Mrs. John DeLime, John and Lauri DeWeese, A. J. Dietrich, Roy C. Hallman, Mrs. Frances Hames, Mrs. D. W. Hundley, David Karraker, Mr. and Mrs. Robert Mason, Russell Mumford, Gideon E. Nelson, Charles P. Preston, Dr. and Mrs. W. P. Randel, William B. Robertson, L. A. Stimson, H. L. Stoddard, Marvin Wass, Mrs. J. F. Wernicke, Richard West, F. M. Weston; *Georgia:* J. Fred Denton, William C. Grimm, Mr. and Mrs. R. E. Hamilton, Frederick V. Hebard, Milton Hopkins, Mrs. Charles Neal, Robert A. Norris, Ivan R. Tomkins; *Louisiana:* Henry B. Chase, John P. Gee, Marshall B. Eyster, H. H. Jeter, Robert B. Lea, George H. Lowery, Robert J. Newman, Ava R. Tabor, Robert E. Tucker; *Mississippi:* Thomas D. Burleigh, M. G. Vaiden; *North Carolina:* Mrs. Edna L. Appleberry, Bob Holmes, III; *South Carolina:* Gabriel Cannon; *Tennessee:* Howard T. Barbig, Richmond Gill, Mrs. Katherine Goodpasture, Lee R. Herndon, Luther Keeton, Lawrence C. Kent, Mrs. Amelia R. Laskey, Harry C. Monk, Mrs. R. A. Munroe, George Peyton, Kilian Roever, James T. Tanner; *Texas:* Nance Cunningham, John V. Dennis, Luther Goldman, Mrs. Jack Hagar, Joseph M. Heiser, C. E. Hudson, Jr., Mrs. Minor A. Hurst, Robert M. Lockwood, Fred Packard, J. R. Schmidt, Dorothy Snyder, Carrie Wilcox, George G. Williams, Stephen Williams; *Virginia:* Fred Behrend, H. Branch Howe, Jr., Locke L. Mackenzie, Frederic R. Scott, C. E. Stevens, Jr.; *Mexico:* Don Eckelberry, Frederick W. Loetscher, Jr., George M. Sutton; *Central America:* Douglas Lancaster,

Mrs. Alice S. Marionneaux, Raymond A. Paynter, Jr., E. M. Reilly, Jr., Stephen M. Russell, Alexander F. Skutch; *West Indies:* James Bond, Florentina Garcia de Montana, Lawrence H. Walkinshaw.

Evidence from Direct Observation

Trans-Gulf Migration.—Lowery and Newman (1954) listed 73 species of non-pelagic birds which have been seen over the open Gulf, and recent observations of others have added a few more. Circumstantial evidence strongly indicated that the great majority of these were engaging in a true migration across the Gulf of Mexico. Considering the fact that many of them were small land birds which migrate largely at night, and that the opportunities of seeing small birds migrating over water are ordinarily fewer, even by day, than for those following land routes, this list is fairly impressive. (Moderate to large numbers of land birds are regularly present on the Dry Tortugas, Florida, in spring, but I saw only one—a Palm Warbler (*Dendroica palmarum*)—on a 12-hour boat trip from Key West to the Tortugas and return, March 23 and 30, 1951.) There is reason to doubt, however, that the list is an infallible index as to which birds are the most common components of the trans-Gulf spring migration. Moreover, in addition to birds seen offshore, some of those seen from land may be safely classed as trans-Gulf migrants. Among my own records have been two thrushes (*Hylocichla* sp.) flying low over the water, in the face of a strong north wind, toward the Alabama coast on April 26, 1952 (one was later determined to have been an Olive-backed Thrush, *H. ustulata*); a Veery (*H. fuscescens*) at the same place under similar circumstances on April 30, 1955; and a Chimney Swift (*Chaetura pelagica*) coming into Alligator Point, northwestern Florida, April 19, 1954. Similar observations have been reported to me by others.

Some references to trans-Gulf migration have implied a flight originating in Yucatan or Central America, but there is some direct evidence that an important flight also originates from, or crosses, the West Indies and continues across the Gulf in a northwesterly direction. On Loggerhead Key, the outermost of the Dry Tortugas, John DeWeese and I observed an Osprey (*Pandion haliaetus*) approach from the southeast and continue across the island and over the Gulf until it disappeared from sight to the northwest. At dusk that day (March 25) a small flock of Yellow-crowned Night Herons (*Nyctanassa violacea*), calling continuously, followed the same route. Consideration of the winter ranges of certain species, coupled with their distribution in spring, leads me to suspect that this is a widely used migration route. The occasional (or regular?) occurrence as far west as Texas of such species as the Black-poll Warbler (*Dendroica striata*) and the Cape May Warbler (*Dendroica tigrina*) is more logically accounted for in this way than by the sup-

position that they have followed a land route northward, then westward, around the Gulf.

Another trans-Gulf route, roughly parallel to this one, extends from Yucatan to the Texas coast (Lowery and Newman, 1954). Quantitative data secured in the course of the present study lead me to agree that this route, not often mentioned in the literature, is followed by many birds.

Circum-Gulf Migration.—If this term be used to include all coastwise migration on the Gulf of Mexico, many observations confirm its magnitude. However, it is both logical and patent that birds wintering in the West Indies often move northward along the Florida Peninsula, and that those which winter in eastern Mexico fly along the Texas coast. More pertinent questions are, "To what extent are these routes utilized by birds wintering in Central and South America?" and "Do these migrants continue eastward (from Texas) and westward (from peninsular Florida) around the northern Gulf coast?" In the case of a few species, the second question may be answered in the affirmative. In northwestern Florida, White Pelicans (*Pelecanus erythrorhynchos*) and White Ibises (*Eudocimus albus*) may be seen following the coast westward in spring, and Williams (1945) has cited records of a northeastward movement of Broad-winged Hawks (*Buteo platypterus*), Little Blue Herons (*Florida caerulea*), four species of swallows, and a few other small land birds around Galveston Bay, Texas. Other records of this nature are represented in Table 3. Such direct observations cannot show the entire route followed by an individual bird in its spring migration, nor do they reveal its winter and summer homes. Therefore they fail to solve some of the problems of migration, and other lines of evidence, even through circumstantial, must be sought.

Comparative Abundance of Migrants around the Gulf

The statement has been made that no transient species is more common along the northern Gulf coast than on the Texas or Florida coasts, but only 56 species formed the basis for the statement (Williams, 1945: 103). The basis for this comparison, except in Texas, was information gleaned from such standard reference works as the state bird books, which used such descriptive terms as "common" and "fairly common" instead of numerical data. That these terms are often misleading is exemplified by Howell's (1932) statement that the Wood Thrush (*Hylocichla mustelina*) is a "fairly common migrant in central Florida." Howell cited only a single spring record for the mainland south of the northern tier of counties (where it breeds). The 23 intervening years have produced very few more. Another innocent error committed by Williams in making this comparison was that of treating as units areas which are ornithologically diverse. For example, the region called the "Florida Peninsula and Keys" consists of the following: (1) the Northern Peninsula,

FIG. 1. Regions Represented by Quantitative Data. 1. Western Tennessee; 2. Northwestern Mississippi; 3. Central Tennessee; 4. Northern Alabama; 5. Northern Georgia; 6. Southwestern Virginia (including northeastern Tennessee); 7. Charlottesville, Virginia; 8. Richmond, Virginia; 9. Virginia-North Carolina Coast; 10. Northwestern Louisiana;

in which most species of transient land birds are scarce (Longstreet, 1930 and 1939; Mason, 1937 and 1939; McClanahan, 1935); (2) the Southern Peninsula, where most of these species are less scarce; and (3) the Lower Keys and Dry Tortugas, where the abundance or regular occurrence of certain species is astonishing to a visitor from the mainland.

An inspection of the winter and summer ranges of North American birds shows that, instead of the 56 species tabulated by Williams, at least 200 may be expected on geographical grounds to cross the Gulf of Mexico with some regularity. Whether these be classed as transients, winter residents, or summer residents along the northern Gulf coast, all are to be considered in an exhaustive study of the problem. Discrepancies such as that mentioned for the Wood Thrush made it advisable to conduct a cooperative study of the relative abundance of migrant species in the southern United States. Between 1946 and 1955 cooperators were asked to record the numbers of individuals of all birds seen from early March to late May, as well as the length of time they spent afield. By dividing for each species the total number of individuals seen by the number of observer-hours afield in a given region, a "frequency" was obtained which could be compared with the frequency of that species in other regions. It was requested that these field data represent a balance of the various habitats, weather conditions, and times of spring (Table 1). The role of chance was further reduced by combining the records of several observers and several localities in each region, and by the fact of the large amounts of field work in each region (not less than 150 hours). The latest revision of these data brought about such minor changes in the frequencies of most species that I am convinced of their general significance. In this connection, the *magnitude* of the differences in many of the frequencies on the northern Gulf coast compared with those on the Florida Peninsula, for example, should be cited in support of the conclusions reached. The 24 regions contributing quantitative data are shown on Fig. 1.

Analysis of Inland Regions.—Results are generally consistent except for species requiring special habitats (waterfowl, etc.). Many transients and summer residents are comparatively common at least 200 miles north of the Gulf, illustrating the "coastal hiatus" of Lowery (1945, *et seq.*). Values for transient land birds at Tallahassee, Florida, just 30 miles inland, are particularly low. Very high counts and estimates were made at Rosedale (northern

11. Brownsville, Texas; 12. Corpus Christi, Texas; 13. Galveston, Texas; 14. Louisiana Coast; 15. Alabama Coast (including northwestern Florida); 16. Tallahassee, Florida; 17. Apalachee Bay, Florida; 18. Northern Florida Peninsula; 19. Southern Florida Peninsula; 20. Dry Tortugas, Florida; 21. West Indies (Western Cuba and Isle of Pines); 22. Southeastern San Luis Potosi, Mexico; 23. Veracruz, Mexico; 24a. British Honduras; 24b. Aguadulce, Panama.

TABLE 1

PERIODIC DISTRIBUTION OF QUANTITATIVE SPRING DATA, TEXAS TO FLORIDA
Values Given are the Percentage of the Observers' Time in the Field

Periods	REGIONS: Brownsville	Corpus Christi	Galveston	Southern Louisiana	Alabama Coast	Tallahassee	Apalachee Bay	No. Fla. Peninsula	So. Fla. Peninsula	Dry Tortugas
Mar. 1-15[1]	6.5	7	4	5	8	7.5	7.5	7.5	4.5	3
Mar. 16-31	17	17.5	16	18	14.5	17	15.5	15.5	17	18.5
Apr. 1-15	20.5	20.5	21	20.5	16	19	19	18	20.5	21.5
Apr. 16-30	27	27	27.5	28.5	26	25	27	25.5	25	25.5
May 1-15	22.5	21	22	19.5	23.5	18	18.5	21	20.5	20.5
May 16-31	6.5	7	9.5	8.5	12	13.5	12.5	12.5	12.5	11
TOTAL HOURS	169	311	151	189	158	274	310	166	424	169

[1]Including Feb. 26 in Southern Florida Peninsula.

Mississippi), but this may be due partly to the convergence of the trans-Gulf stream of migrants passing up the Mississippi River with birds veering northeastward from the Texas coast.

Analysis of Gulf Coastal Regions.—The results are believed to be significant for most species, but probably not for certain shore birds on the Louisiana coast. Frequencies are high for most species on the Dry Tortugas, both for trans-Gulf and circum-Gulf migrants. This is due in part to the concentrating effect of small islands, as well as the probable lingering of individuals for several days, with the result that the same birds were counted more than once. The occurrence there of numbers of species that winter in Central America is usually correlated with westerly or southwesterly winds (Bennett, 1909), as these species ordinarily cross nearer the center of the Gulf.

Analysis of Tropical Regions.—Quantitative field data were available from Cuba, the Isle of Pines (Walkinshaw and Baker, 1946), British Honduras, and Veracruz, and semi-quantitative data from eastern Mexico (Sutton and Burleigh, 1940; Sutton and Pettingill, 1942). It is very doubtful whether these data should be freely compared with those from within the United States in view of the great differences in objectives and methods used in the several regions. Furthermore, because of the need of obtaining as much data from the tropics as possible, I have not selected trips to give a balance for the various periods of spring but used all data available, thus invalidating strict comparisons of these sets of data with each other and with those from within the

TABLE 2

PERIODIC DISTRIBUTION OF QUANTITATIVE SPRING DATA SOUTH OF THE UNITED STATES
Values Given are the Percentage of the Observers' Time in the Field

	San Luis Potosi	Veracruz	Central America	Greater Antilles
March	28.5	32	43	41
April	66.5	36	41	34
May	5	32	16	25

United States (Table 2). Especially have I been cautious in using the semi-quantitative data of Sutton *et al.*, since the numbers used in the study were often based on my own inferences from reading the text.

SEQUENCE OF MIGRATION DATES

From state bird books and other regional lists, papers in state and national journals, and unpublished data received from cooperators, the earliest and latest spring records of the species included in this study were determined in each of 25 regions comparable to those from which quantitative data were ob-obtained (Fig. 2). The significance of this type of data has been the subject of some debate. It has been contended that the sequence of migration dates proves practically nothing. This would indeed be true if each species arrived simultaneously at all points north of its winter range. However, inasmuch as every species appears earlier in some parts of the country than in others, the time of its arrival at various points can indicate the course of its journey.

The danger that lies in the use of migration dates is that of attempting to prove too much from too little. Chance plays so large a part in determining the *recorded* occurrences of species (as opposed to their presence without our knowledge) that data in small amounts actually may prove very little.

In the present study this principle of increasing the amount, and therefore the significance, of the data was applied in several ways. (1) All migration dates from one region have been lumped. For example, the Northern Georgia region includes data from Atlanta, Athens, Dalton, Demorest, Augusta, and Macon. The 25 regions represented cover the entire southeastern United States, eastern Mexico, Central America (including Mexico east of the Isthmus of Tehuantepec), and the West Indies. Even data of this type from the tropics, however, are hardly comparable to those from within the United States. (2) The "average" arrival date was not employed in this study, as it usually consists of representative dates (when the observer was afield frequently) averaged with spurious arrival dates (when opportunities for field work were restricted). Arrival dates used in this study are considered the

earliest normal dates for the region. In many instances, perhaps most, they are the earliest of record in that region. Very exceptional records, however, were omitted, as they might represent wintering, might have been based on faulty identification, or might in some way be anomalous. This introduced the problem of determining which early dates to consider exceptional and which representative. For common species a date five days in advance of the next earliest was considered "out of line," but for less common species a difference of a week or more was required to establish abnormality. Normal and abnormal departure dates were determined in much the same way. (3) In view of the fact that the earliest known record of a species is likely to be earlier in a region where it is common than in one where it is rare—and that, similarly, departure dates are usually later in the region where the bird is common—a *median* date was employed wherever possible. This is simply the date which lies half-way between the earliest and latest normal dates. Use of this date often showed a progression of migration that would not have been apparent from a comparison of arrival dates or departure dates alone.

Fig. 2. Regions in the United States represented by migration dates. (Boundaries which do not coincide with state lines are indicated with broken lines.) 1. Arkansas (including western Tennessee and northwestern Mississippi); 2. Northern Mississippi (including northwestern Alabama); 3. Central Tennessee; 4. Northern Alabama; 5. Northeastern Tennessee-southwestern Virginia; 6. Northern Georgia; 7. Western North Carolina; 8. South Carolina; 9. Eastern North Carolina; 10. Northern Louisiana; 11. Central Alabama; 12. Southeastern Georgia; 13. Brownsville, Texas; 14. Corpus Christi, Texas; 15. Galveston, Texas; 16. Southern Louisiana; 17. Mississippi-Alabama Coast; 18. Northwestern Florida; 19. Tallahassee, Florida; 20. Northern Florida Peninsula; 21. Southern Florida Peninsula (including Upper Keys); 22. Lower Florida Keys.

Use of Maps

Maps were made (Figs. 3-62) showing the winter and summer ranges of each species, even though distribution south of the United States could not always be accurately determined. The frequencies were then plotted on these (odd-numbered) maps, and isoplethal lines were drawn in. (It is not intended that these lines imply certain frequencies for areas outside that under consideration, however close these areas may be.) Frequencies were enclosed in parentheses if they appeared to be no higher than values for the same species in winter or summer, but this was difficult to determine south of the United States. The symbol ".00+" was used to indicate the spring occurrence of species not recorded in the quantitative data used in the study. Superscript letters following these frequencies convey additional information: "a", May be as frequent in summer; "b", May be as frequent in winter; "c", Probably occurs more frequently (whenever these values were lower than those implied for the species by other workers, or lower than they would have been if all quantitative data received from that region had been used in the study). Appropriate symbols (A+, L–, etc.) compared the status of each species in coastal Mississippi (Burleigh, 1944) to its status on the Alabama or Louisiana coast. The area of maximum abundance was shaded. Also all records of birds seen on the Gulf of Mexico were located on these maps by geographic position, date, and number of individuals.

On similar (even-numbered) maps migration dates were transcribed, whether the arrival, median, or departure date, and isochrones used to show the species' advance. Whenever more than one kind of information was given on a single map, appropriate letters before a date show whether it is an arrival, median, or departure date (A, M, or D). Parentheses were placed around all dates based on six or fewer records, indicating their lesser significance. On these maps, "a" associated with a date indicates that exceptional records were omitted from consideration and "b" that the date probably is not representative.

General Results

Comparative Abundance.—From this study it was determined that about 40 species of birds occurred more frequently along the northern Gulf coast than on its eastern and western sides. Although some of these may be open to suspicion on the grounds that they are also more common there in summer or winter, at least 16 of these are primarily of transient status. If the Texas coast north of Brownsville be included with the northern Gulf (on the assumption that many birds arrive there from across the Gulf) the list is greatly increased. The abundance on the Texas coast of certain species which

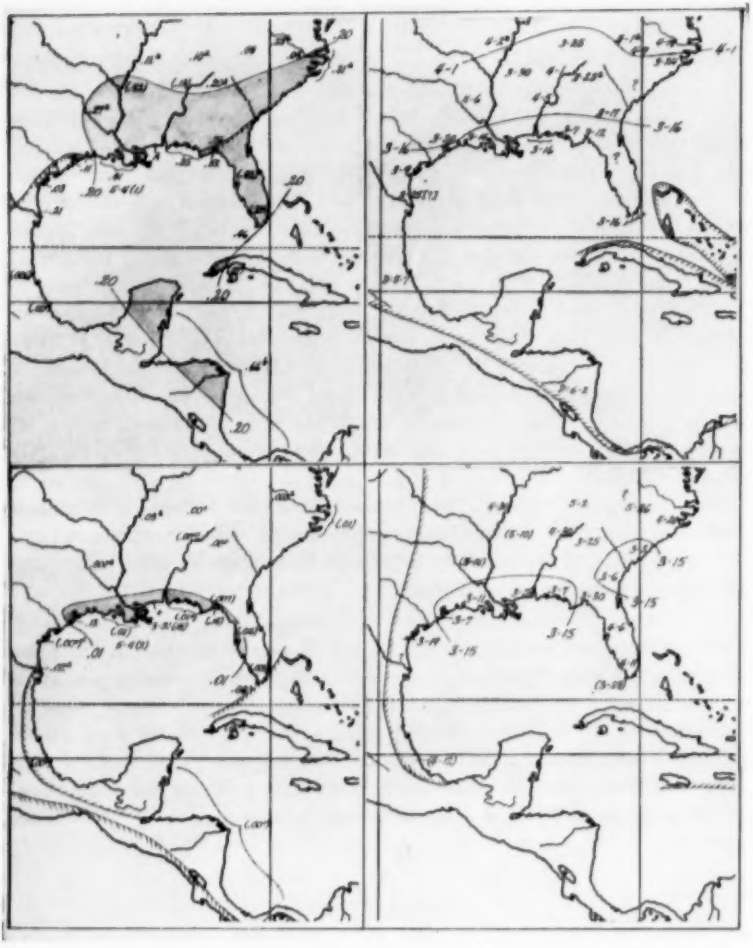

FIG. 3 (upper left) Comparative Abundance and FIG. 4 (upper right) Arrival Dates for the Green Heron.

FIG. 5 (lower left) Comparative Abundance and FIG. 6 (lower right) Arrival Dates for the Least Bittern.

(See text page 47 for further details concerning these maps.)

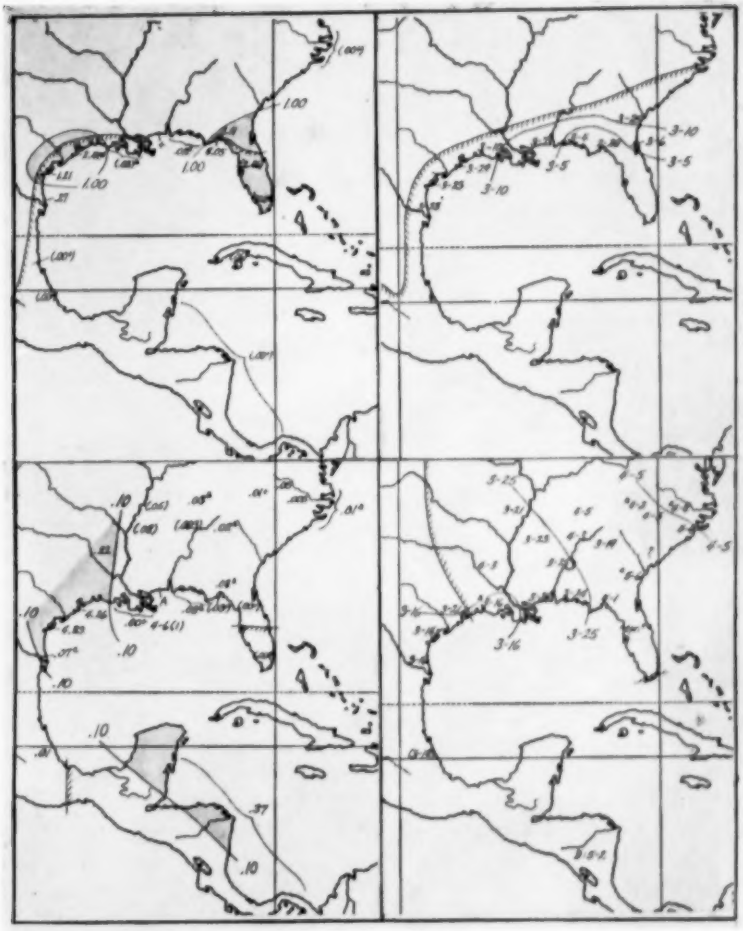

FIG. 7 (upper left) Comparative Abundance and FIG. 8 (upper right) Arrival Dates for the White Ibis.

FIG. 9 (lower left) Comparative Abundance and FIG. 10 (lower right) Arrival Dates for the Broad-winged Hawk.

breed in the eastern United States is surprising, but their occurrence is probably due in part to the prevailingly easterly winds over the Gulf of Mexico in spring. An observer (DeWeese) stationed on the Tortugas recorded easterly winds on 63 of the 101 days on which observations were made; another (Lockwood) at Rockport, Texas, on 66 of 82 days. Furthermore, some species' breeding ranges extend entirely across North America and their winter ranges lie in South America. Therefore an important segment of the population of such species as the Common Nighthawk (*Chordeiles minor*) and Olive-sided Flycatcher (*Nuttallornis borealis*), and of most species of swallows must cross the Texas coast in a direct flight from wintering to breeding grounds. Although the evidence that many species are less common in eastern Mexico than on the Texas coast may still be inconclusive, it is much better validated now than 10 years ago. I submit that the burden of proof that the two are ornithologically similar, insofar as transient species are concerned, now rests on any who may make the statement.

Sequence of Migration Dates.—If migration across the Gulf of Mexico does not occur, all species which appear on the northern side in spring should arrive there later (or certainly not earlier) than they appear *en route* there on the Texas or Florida coast. Conversely, migration across the Gulf, since it must occur in one continuous flight, would bring some individuals of the species to the northern side earlier than those which follow the longer land route, with its opportunities for frequent stopping. Therefore, trans-Gulf migrants should reach the coastal areas of northeastern Texas, Louisiana, Mississippi, Alabama, and northwestern Florida as early as, or earlier than, individuals of the same species arrive in southern Texas or the Florida Peninsula. Departure dates of species which are common in winter on the northern Gulf coast are difficult to interpret. Although later dates here in spring may seem to support the theory of circum-Gulf passage, I believe that in some cases these belated individuals have crossed the Gulf. Later departure dates on the sides of the Gulf, however, seem indicative of a circum-Gulf migration.

This study of the sequence of migration dates indicated that many species utilize the trans-Gulf migration route to some extent in spring. These include some which are of greatest abundance on the northern Gulf coast in spring, but a number of others which are not (Table 3). I doubt seriously whether any small land birds other than swallows follow the northern Gulf coastline eastward or westward to any appreciable extent in spring.

An incidental result of this phase of the study was the discovery of early arrival (or median) dates along the Atlantic coast of certain species whose winter ranges include parts of the West Indies or South America. Such species were the Least Bittern (*Ixobrychus exilis*), Stilt Sandpiper (*Micropalama himantopus*), Least Tern (*Sterna albifrons*), Chuck-will's-widow (*Caprimulgus*

carolinensis), Common Nighthawk (*Chordeiles minor*), Cliff Swallow (*Petrochelidon pyrrhonota*), Veery (*Hylocichla fuscescens*), Red-eyed Vireo (*Vireo olivaceus*), Magnolia Warbler (*Dendroica magnolia*), Black-poll Warbler (*Dendroica striata*), American Redstart (*Setophaga ruticilla*), Bobolink (*Dolichonyx oryzivorus*), and Painted Bunting (*Passerina ciris*). (A few of these species also winter in south Florida and may have moved northward from there.) The implication is that some individuals fly across a small part of the western Atlantic. This theory receives some support from the records of many birds (but mostly of other species) in the western Atlantic in spring (Scholander, 1955).

Relationship to Adverse Weather.—The effect of a cold front, with or without rain, in precipitating trans-Gulf migrants is well known, but in my opinion the scarcity of migrants at other times has been overstated. Rain without a cold front precipitates many migrants; and, in fact, even under weather conditions ideal for continued overhead migration a few migrants are nearly always present along the coast. That these invariably are "hold-overs" from the last cold front seems improbable.

Systematic Account[1]

Explanation of Table 3.—In an effort to summarize the results of this study, evidence favoring each of the two migration routes is presented for 164 species in Table 3. (Data were too inconclusive for species omitted from the table.) Under the heading "Direct Observation," the number of records is given for each species seen over the Gulf ("Trans-Gulf") or flying around some part of the northern Gulf between Galveston Bay, Texas, and Apalachee Bay, Florida ("Circum-Gulf"). In the latter column the letter "w" indicates records of birds flying west and "e" those flying east. Under "Comparative Abundance" and "Sequence of Dates," the letter "x" (or, more doubtfully, "?") is used to symbolize the bulk of the migration.

COLYMBIFORMES AND PELECANIFORMES. The Pied-billed Grebe, a permanent resident over much of the study area, was a difficult subject, but there seems to be no evidence of a trans-Gulf migration. The same is true of the White Pelican and Anhinga. Significantly, all three species are unknown or are virtually so on the Dry Tortugas.

CICONIIFORMES. Most of the waders stick to the mainland in their migrations, but a few individuals of each species may venture across the Gulf. The Green Heron and Least Bittern (Figs. 3-6), however, appear to be chiefly trans-Gulf migrants, and perhaps the Yellow-crowned Night Heron is regularly, though not predominantly, so. All indications point to the exclusively circum-Gulf migration of the White Ibis (Figs. 7 and 8).

ANSERIFORMES. There is no conclusive evidence of trans-Gulf migration in any of the 16 species of ducks and geese included in this study. In fact, the winter ranges of most are largely within the United States and Mexico.

[1]Scientific names of all species mentioned in this section may be found in Table 3.

TABLE 3

SUMMARY OF EVIDENCE PERTINENT TO MIGRATION ROUTES[1]

Species	Direct Observation		Comparative Abundance		Sequence of Dates	
	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf
Pied-billed Grebe (*Podilymbus podiceps*)	–	—	–	x	–	x
White Pelican (*Pelecanus erythrorhynchos*)	–	3w;1e	–	x	–	x
Anhinga (*Anhinga anhinga*)	–	—	–	x	–	?
Great Blue Heron (*Ardea herodias*)	2	1e	–	?	–	–
Common Egret (*Casmerodius albus*)	–	1e	–	?	–	–
Snowy Egret (*Leucophoyx thula*)	–	1e	–	?	–	–
Louisiana Heron (*Hydranassa tricolor*)	1	2e	–	?	–	–
Little Blue Heron (*Florida caerulea*)	–	3e	–	x	–	?
Green Heron (*Butorides virescens*)	1	—	x	?	?	–
Black-crowned Night Heron (*Nycticorax nycticorax*)	–	1e	–	?	–	–
Yellow-crowned Night Heron (*Nyctanassa violacea*)	1	—	–	–	?	–
American Bittern (*Botaurus lentiginosus*)	1	—	?	–	–	–
Least Bittern (*Ixobrychus exilis*)	2	—	x	–	x	–
White Ibis (*Eudocimus albus*)	–	3w;1e	–	x	–	x
Mallard (*Anas platyrhynchos*)	–	—	?	–	–	?
Gadwall (*Anas strepera*)	–	—	–	?	–	?
Pintail (*Anas acuta*)	–	—	–	?	–	x
Green-winged Teal (*Anas carolinensis*)	–	—	–	x	–	x
Blue-winged Teal (*Anas discors*)	–	3w;1e	–	x	–	x
American Widgeon (*Mareca americana*)	–	—	–	x	–	x
Shoveller (*Spatula clypeata*)	–	1e	–	x	–	x
Redhead (*Aythya americana*)	–	—	–	x	–	x
Ring-necked Duck (*Aythya collaris*)	–	—	–	x	–	?
Canvasback (*Aythya valisineria*)	–	—	–	?	–	?
Lesser Scaup (*Aythya affinis*)	–	1w	–	?	–	–
Ruddy Duck (*Oxyura jamaicensis*)	–	—	–	x	–	–
Turkey Vulture (*Cathartes aura*)	1	—	–	?	–	–
Swallow-tailed Kite (*Elanoides forficatus*)	–	—	–	–	–	x
Mississippi Kite (*Ictinia misisippiensis*)	–	—	–	–	–	–
Sharp-shinned Hawk (*Accipiter striatus*)	–	—	–	x	–	x
Cooper's Hawk (*Accipiter cooperii*)	–	—	–	?	–	x
Broad-winged Hawk (*Buteo platypterus*)	1	1e	?	?	–	x
Marsh Hawk (*Circus cyaneus*)	–	—	–	x	–	x
Osprey (*Pandion haliaetus*)	1	—	–	?	–	x
Peregrine Falcon (*Falco peregrinus*)	1	1w	–	?	?	?
Pigeon Hawk (*Falco columbarius*)	1	—	–	?	?	?
Sparrow Hawk (*Falco sparverius*)	2	—	?	–	–	–
Sora (*Porzana carolina*)	1	—	x	–	x	–
Purple Gallinule[2] (*Porphyrula martinica*)	1	—	–	x	?	?
American Coot (*Fulica americana*)	1	—	–	?	–	–
Semipalmated Plover (*Charadrius hiaticula*)	–	—	–	x	–	–
Wilson's Plover (*Charadrius wilsonia*)	–	—	–	x	–	x

(Continued on next page)

[1]Omitting species for which data are inadequate or inconclusive.
[2]The Florida Gallinule (**Gallinula chloropus**), omitted from this study, has also been found on the open Gulf (Bullis and Lincoln, 1952).

TABLE 3. — (Continued)

Species	Direct Observation		Comparative Abundance		Sequence of Dates	
	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf
Golden Plover (*Pluvialis dominica*)	–	—	x	–	?	–
Black-bellied Plover (*Squatarola squatarola*)	–	—	–	x	–	–
Ruddy Turnstone (*Arenaria interpres*)	–	—	–	x	–	–
Wilson's Snipe (*Capella gallinago*)	–	—	–	x	–	?
Long-billed Curlew (*Numenius americanus*)	1	—	–	?	–	–
Hudsonian Curlew (*Numenius hudsonicus*)	–	—	–	?	–	x
Upland Plover (*Bartramia longicauda*)	–	1w	x	–	x	–
Spotted Sandpiper (*Actitis macularia*)	–	—	x	x	x	–
Solitary Sandpiper (*Tringa solitaria*)	–	—	x	–	x	–
Willet (*Catoptrophorus semipalmatus*)	–	—	–	x	–	–
Greater Yellow-legs (*Totanus melanoleucus*)	–	—	–	?	–	–
Lesser Yellow-legs (*Totanus flavipes*)	–	—	–	?	–	–
American Knot (*Calidris canutus*)	–	—	–	?	–	x
Pectoral Sandpiper (*Erolia melanotos*)	–	—	x	–	x	–
White-rumped Sandpiper (*Erolia fuscicollis*)	–	—	?	–	?	?
Baird's Sandpiper (*Erolia bairdi*)	–	—	x	–	?	–
Least Sandpiper (*Erolia minutilla*)	1	—	–	x	–	–
Dowitchers (*Limnodromus griseus, L. scolopaceus*)	–	—	–	x	–	–
Stilt Sandpiper (*Micropalama himantopus*)	–	—	x	–	x	–
Semipalmated Sandpiper (*Ereunetes pusillus*)	1	1w	x	–	?	?
Western Sandpiper (*Ereunetes mauri*)	–	—	?	?	–	?
Buff-breasted Sandpiper (*Tryngites subruficollis*)	–	—	x	–	?	–
Marbled Godwit (*Limosa fedoa*)	–	—	–	?	–	–
Hudsonian Godwit (*Limosa haemastica*)	–	—	?	?	–	–
Sanderling (*Crocethia alba*)	–	—	?	–	–	–
Black-necked Stilt (*Himantopus mexicanus*)	–	—	?	?	?	?
Wilson's Phalarope (*Steganopus tricolor*)	–	—	?	?	–	?
Herring Gull (*Larus argentatus*)	2	—	x	–	–	–
Least Tern (*Sterna albifrons*)	–	—	–	?	–	?
Cabot's Tern (*Thalasseus sandvicensis*)	–	—	?	–	–	?
Black Tern (*Chlidonias niger*)	–	—	x	–	?	–
Mourning Dove (*Zenaidura macroura*)	3	—	?	?	–	–
Ground Dove (*Columbigallina passerina*)	–	1w	–	x	–	–
Yellow-billed Cuckoo (*Coccyzus americanus*)	1	—	x	–	x	–
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	–	—	x	–	x	–
Short-eared Owl (*Asio flammeus*)	–	—	–	x	–	x
Chuck-will's-widow (*Caprimulgus carolinensis*)	–	—	–	x	–	x
Common Nighthawk (*Chordeiles minor*)	3	—	x	?	x	x
Chimney Swift (*Chaetura pelagica*)	2	—	–	x	x	–
Ruby-throated Hummingbird (*Archilochus colubris*)	2	—	x	–	x	x
Belted Kingfisher (*Megaceryle alcyon*)	3	—	x	x	–	–
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	–	—	x	–	x	x
Eastern Kingbird (*Tyrannus tyrannus*)	1	1e	x	–	x	–
Gray Kingbird (*Tyrannus dominicensis*)	1	—	–	x	–	x
Western Kingbird (*Tyrannus verticalis*)	–	—	?	–	–	?
Scissor-tailed Flycatcher (*Muscivora forficata*)	–	—	?	–	?	–
Crested Flycatcher (*Myiarchus crinitus*)	–	—	x	–	x	–
Eastern Phoebe (*Sayornis phoebe*)	1	—	–	–	–	?

(Continued on next page)

TABLE 3. — (Continued)

Species	Direct Observation		Comparative Abundance		Sequence of Dates	
	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf
Yellow-bellied Flycatcher (*Empidonax flaviventris*)	–	—	?	?	?	?
Acadian Flycatcher (*Empidonax virescens*)	–	—	x	–	x	–
Traill's Flycatcher (*Empidonax traillii*)	–	—	?	?	?	?
Least Flycatcher (*Empidonax minimus*)	–	—	x	–	x	–
Empidonax sp.?	–	—	–	x	–	–
Eastern Wood Pewee (*Contopus virens*)	–	—	x	–	x	–
Olive-sided Flycatcher[1] (*Nuttallornis borealis*)	1	—	?	?	–	?
Tree Swallow (*Iridoprocne bicolor*)	3	1w	–	x	–	x
Bank Swallow (*Riparia riparia*)	2	1e;1w	x	–	?	?
Rough-winged Swallow (*Stelgidopteryx ruficollis*)	–	1e	?	?	x	–
Barn Swallow (*Hirundo rustica*)	8	1e;1w	x	–	x	–
Cliff Swallow (*Petrochelidon pyrrhonota*)	2	1e;1w	–	x	–	x
Purple Martin (*Progne subis*)	2	2e	x	–	x	–
House Wren (*Troglodytes aedon*)	–	—	–	x	–	x
Catbird (*Dumetella carolinensis*)	1	—	x	–	x	–
American Robin (*Turdus migratorius*)	1	—	?	–	?	?
Wood Thrush (*Hylocichla mustelina*)	2	—	x	–	x	–
Hermit Thrush (*Hylocichla guttata*)	–	—	?	–	–	?
Olive-backed Thrush (*Hylocichla ustulata*)	1	—	x	–	x	–
Gray-cheeked Thrush (*Hylocichla minima*)	–	—	x	–	x	–
Veery (*Hylocichla fuscescens*)	2	—	x	–	x	–
Blue-gray Gnatcatcher (*Polioptila caerulea*)	–	—	–	?	–	x
Ruby-crowned Kinglet (*Regulus calendula*)	–	—	?	?	–	?
American Pipit (*Anthus spinoletta*)	–	—	?	?	?	–
Cedar Waxing (*Bombycilla cedrorum*)	–	—	x	–	?	–
White-eyed Vireo (*Vireo griseus*)	–	—	?	?	?	–
Bell's Vireo (*Vireo bellii*)	–	—	–	x	–	x
Yellow-throated Vireo (*Vireo flavifrons*)	–	—	x	–	?	?
Blue-headed Vireo (*Vireo solitarius*)	–	—	?	?	?	x
Red-eyed Vireo (*Vireo olivaceus*)	1	—	x	–	x	–
Philadelphia (*Vireo philadelphicus*)	–	—	?	–	?	–
Warbling Vireo (*Vireo gilvus*)	–	—	x	–	x	–
Black-and-white Warbler (*Mniotilta varia*)	4	1w	x	x	x	–
Prothonotary Warbler (*Protonotaria citrea*)	4	—	x	–	x	–
Swainson's Warbler (*Limnothlypis swainsonii*)	–	—	x	–	?	?
Worm-eating Warbler (*Helmitheros vermivorus*)	4	1w	x	?	x	–
Golden-winged Warbler (*Vermivora chrysoptera*)	1	—	?	?	x	–
Blue-winged Warbler (*Vermivora pinus*)	–	—	?	?	x	–
Bachman's Warbler (*Vermivora bachmanii*)	–	—	–	–	x	–
Tennessee Warbler (*Vermivora peregrina*)	–	—	x	–	x	–
Orange-crowned Warbler (*Vermivora celata*)	–	—	?	?	–	x
Nashville Warbler (*Vermivora ruficapilla*)	1	—	–	x	x	–
Parula Warbler (*Parula americana*)	4	1w	x	–	x	x
Yellow Warbler (*Dendroica petechia*)	3	1e;1w	x	?	x	–
Magnolia Warbler (*Dendroica magnolia*)	2	—	x	?	?	?
Cape May Warbler (*Dendroica tigrina*)	4	—	–	x	–	x

(Continued on next page)

[1]The Vermilion Flycatcher (**Pyrocephalus rubinus**), omitted from this study, has once been found on the open Gulf (Bullis and Lincoln, 1952).

TABLE 3. — (Continued)

Species	Direct Observation		Comparative Abundance		Sequence of Dates	
	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf
Black-throated Blue Warbler (*Dendroica caerulescens*)	1	—	–	x	x	?
Myrtle Warbler (*Dendroica coronata*)	6	1w	x	–	x	x
Black-throated Green Warbler (*Dendroica virens*)	1	—	–	x	?	?
Cerulean Warbler (*Dendroica cerulea*)	1	—	x	–	x	–
Blackburnian Warbler (*Dendroica fusca*)	–	—	x	?	x	–
Yellow-throated Warbler (*Dendroica dominica*)	1	—	x	–	x	x
Chestnut-sided Warbler (*Dendroica pensylvanica*)	1	—	x	–	x	–
Bay-breasted Warbler (*Dendroica castanea*)	1	—	x	–	x	–
Black-poll Warbler (*Dendroica striata*)	2	—	–	x	x	–
Prairie Warbler (*Dendroica discolor*)	–	—	–	x	?	x
Palm Warbler (*Dendroica palmarum*)	1	—	–	x	–	x
Ovenbird (*Seiurus aurocapillus*)	1	—	x	–	x	–
Northern Water-thrush (*Seiurus noveboracensis*)	1	—	x	–	–	x
Louisiana Water-thrush (*Seiurus motacilla*)	2	—	x	–	x	–
Kentucky Warbler (*Oporornis formosus*)	4	—	x	–	x	–
Mourning Warbler (*Oporornis philadelphia*)	1	—	–	x	x	–
Yellow-throat (*Geothlypis trichas*)	4	—	–	x	–	–
Yellow-breasted Chat (*Icteria virens*)	–	—	?	x	–	x
Hooded Warbler (*Wilsonia citrina*)	2	—	x	–	x	–
Wilson's Warbler (*Wilsonia pusilla*)	1	—	?	x	–	–
Canada Warbler (*Wilsonia canadensis*)	–	—	–	x	–	x
American Redstart (*Setophaga ruticilla*)	8	1w	x	x	x	–
Bobolink (*Dolichonyx oryzivorus*)	3	—	x	x	?	?
Orchard Oriole (*Icterus spurius*)	5	—	x	–	x	–
Baltimore Oriole (*Icterus galbula*)	2	—	x	–	x	x
Scarlet Tanager (*Piranga olivacea*)	3	—	x	–	x	x
Summer Tanager (*Piranga rubra*)	3	—	x	–	x	x
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	–	—	x	–	x	x
Blue Grosbeak (*Guiraca caerulea*)	–	—	x	?	x	–
Indigo Bunting (*Passerina cyanea*)	3	1e	x	?	x	–
Painted Bunting (*Passerina ciris*)	1	—	x	?	x	–
Dickcissel (*Spiza americana*)	1	—	x	?	x	x
Savannah Sparrow (*Passerculus sandwichensis*)	–	—	?	x	–	x
Grasshopper Sparrow (*Ammodramus savannarum*)	1	—	–	x	–	x
Lincoln's Sparrow (*Melospiza lincolnii*)	–	—	–	x	–	x

FALCONIFORMES. Turkey Vultures move northward along the Texas and Florida coasts to some extent in spring. Although there seems to be no record of any far from land, Van Tyne and Trautman (1945) witnessed what appeared to be the beginning of a trans-Gulf migration. Swallow-tailed Kites are seldom encountered south of their breeding grounds, but the few migration records are all from land areas. It seems almost certain that the Mississippi Kite follows the coast from Veracruz through Texas in reaching its breeding grounds. Whether the same is true of the Broad-winged Hawk is much less certain, as comparatively few have been reported in Mexico and one was recorded off the Louisiana coast (Figs. 9 and 10). It seems probable that most cross

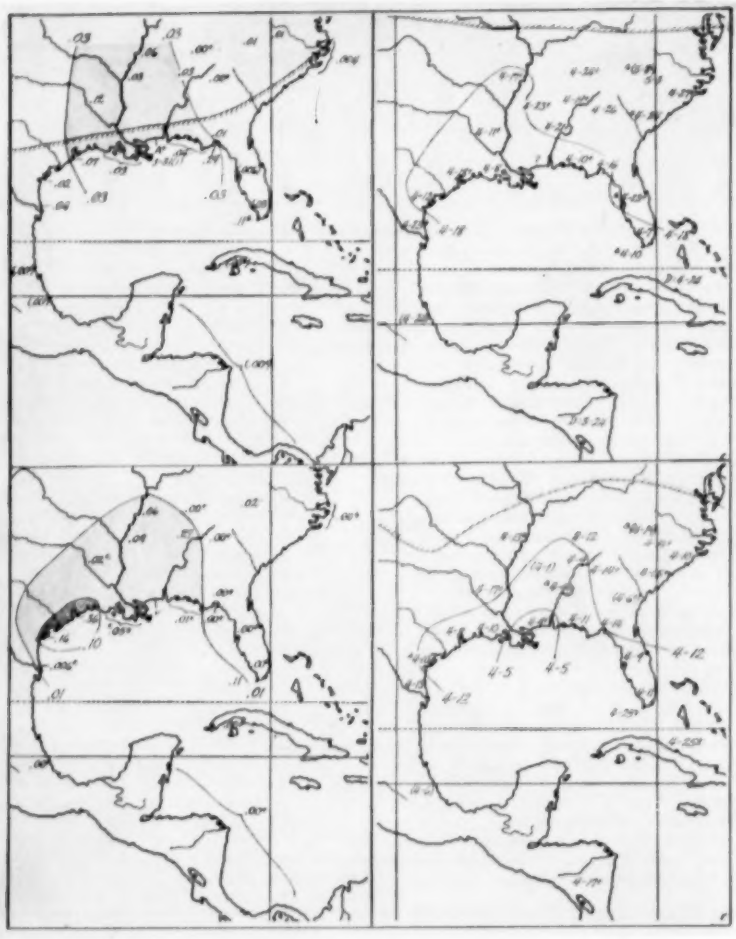

FIG. 11 (upper left) Comparative Abundance and FIG. 12 (upper right) Median Dates for the Sora.

FIG. 13 (lower left) Comparative Abundance and FIG. 14 (lower right) Median Dates for the Upland Plover.

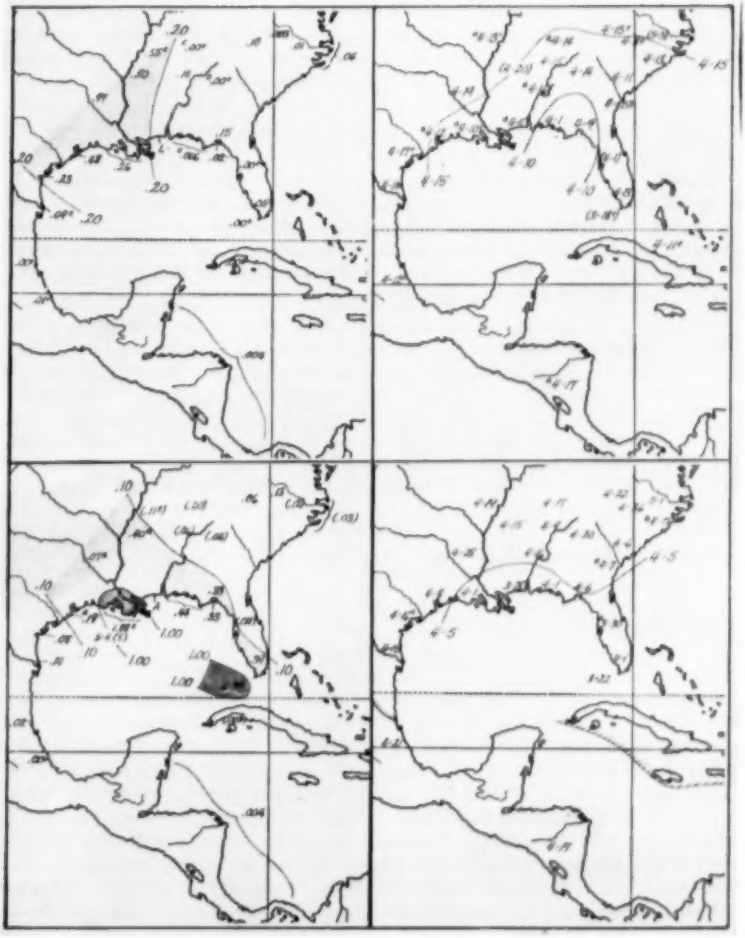

FIG. 15 (upper left) Comparative Abundance and FIG. 16 (upper right) Median Dates for the Pectoral Sandpiper.

FIG. 17 (lower left) Comparative Abundance and FIG. 18 (lower right) Arrival Dates for the Yellow-billed Cuckoo.

from Yucatan to the Texas coast, then turn northward and northeastward. Sharp-shinned and Cooper's hawks follow coastal and inland routes in spring. Marsh Hawks probably do the same, but I would not rule out the likelihood of an occasional individual's crossing the Gulf. Despite my observation on the Tortugas, there is nothing to indicate a regular trans-Gulf flight of Ospreys in spring. Falcons are well known for their coastwise migrations, but each of the three eastern species has been observed on the Gulf one time, and it is not unlikely that a few of these strong flyers make the long flight across.

RALLIDAE. Pertinent data on the Virginia and Black rails are too meagre to be indicative, but there is abundant circumstantial evidence that the Sora crosses the Gulf with regularity (Figs. 11 and 12). This is also true of the Purple Gallinule, which arrives earlier on the northern Gulf than on the Texas coast. Despite the general abundance of the species, only one Coot has been found on the open Gulf and it is only a few miles offshore. Apparently few or none cross the Gulf of Mexico.

CHARADRIIDAE. Piping and Snowy plovers are shore birds of comparatively northerly winter ranges, and presumably few individuals which breed in the United States winter south of the Gulf. There is no reason to doubt that they follow the coast lines in the manner of most shore birds. Quantitative data indicate that most Semipalmated Plovers do also, and there is no record of one far offshore. Wilson's and Black-bellied plovers and the Ruddy Turnstone are more common on the east and west sides of the Gulf, and Wilson's usually arrives there earlier in spring; but each species was encountered much less frequently in Mexico. Comparatively few Killdeer winter south of the Gulf of Mexico, and there is no indication that these cross the Gulf in spring. Golden Plovers must, however, be regarded as trans-Gulf migrants, as significant numbers have not been reported from eastern Mexico. The highest coastal frequencies by far are in Texas and Louisiana.

SCOLOPACIDAE. Most members of this group were more common on the eastern or western Gulf, but values in Mexico were usually low. This was true of Wilson's Snipe, but I believe that the few, out-of-place individuals found on the northern Gulf coast in late spring have flown across. Despite the fact that the Long-billed Curlew is most common in spring on the Texas coast, a record of seven off the Louisiana coast (Lowery, 1946) denotes a Gulf crossing for some. Most Hudsonian Curlews follow coastal routes within the United States, but Mexican records are few at this date. Both the quantitative data and the sequence of migration dates imply a trans-Gulf passage for the Upland Plover, most individuals reaching land in Texas or Louisiana (Figs. 13 and 14). There are, almost surely, important migrations of Spotted Sandpipers both around and across the Gulf. The bulk of the Solitary Sandpipers crosses the Gulf west of the Dry Tortugas, where the species has not been recorded in spring; smaller numbers apparently follow each side of the Gulf northward. Pectoral (Figs. 15 and 16), White-rumped, Baird's, and Buff-breasted sandpipers appear to be trans-Gulf migrants most common on the Texas coast (and Louisiana, in the case of the Pectoral). The Stilt Sandpiper may fall into this category in spite of its wide winter range in Mexico. The Hudsonian Godwit is too rare to appraise at this time, and the Marbled Godwit is often as common in winter as in spring. A large-scale trans-Gulf migration for the remaining members of this family seems improbable, but reliable migration dates were unobtainable on the Gulf for such non-breeding permanent residents as the Dowitchers, Sanderling, and most of the "peeps." There are, however, direct observations both of trans-Gulf and circum-Gulf migration in the Semipalmated Sandpiper.

RECURVIROSTRIDAE AND PHALAROPODIDAE. The Black-necked Stilt is temporarily classified as a chiefly trans-Gulf migrant to the coast of Texas and Louisiana. Until evidence of

numbers is forthcoming from Mexico, Wilson's Phalarope must also be reckoned a trans-Gulf migrant even though the center of spring abundance is the *southern* coast of Texas.

LARIDAE. The resident habits of the gulls render them difficult subjects for this study, but there are indications that some Herring Gulls cross the Gulf of Mexico in spring. Because of the difficulties of distinguishing them in the field, Forster's and Common terns have yielded little data of value in this study. Least Terns, unrecorded far offshore in the Gulf, reach the Texas and Florida coasts earlier than the northern Gulf, and hence are primarily circum-Gulf in their spring migration. The same route seems to be followed by other species of terns with the striking exception of the Black Tern, which, for all its abundance on the Texas coast, seems to be entirely lacking in spring in Mexico.

COLUMBIDAE. Although the two common species of doves are resident in most parts of the South, three Mourning Dove records on the Gulf provide direct evidence of the trans-Gulf flight of this species. It appears likely that most of the White-winged Doves appearing in Texas in spring have moved northward from Mexico.

CUCULIDAE. Large numbers of Yellow-billed Cuckoos cross the Antilles (?), Florida Keys, and Gulf of Mexico in spring, the greatest numbers precipitating on or passing over the Louisiana coast (Figs. 17 and 18). Black-billed Cuckoos cross on a more westerly course, appearing in eastern Mexico almost as frequently as from Texas to Alabama.

CAPRIMULGIDAE. All evidence suggests a heavy migration of Chuck-will's-widows northward on the Florida Peninsula, but whether all of those breeding north of the Gulf arrive from this route is doubtful. Data on the Whip-poor-will were inconclusive, but there is every indication that Common Nighthawks arrive almost simultaneously and occur in comparable numbers all around the Gulf in the United States, some having been seen arriving from over the Gulf (F. M. Weston, *fide* Lowery, 1946) (Figs. 19 and 20). By contrast, Mexican records are few in spring and the numbers negligible.

APODIFORMES. Chimney Swifts apparently migrate on a wide front, but the largest coastal numbers appear in Texas. I have seen one arriving from over the Gulf and believe that many follow this course, although Loetscher (1955) describes an important migration along the eastern coast of Mexico. The Ruby-throated Hummingbird, long cited as a trans-Gulf migrant, is uncommon in most of Florida and apparently rather rare in Mexico, but occurs in large numbers on the Dry Tortugas and the coasts of Louisiana and Texas.

ALCEDINIDAE AND PICIDAE. Two records of the Belted Kingfisher on the Gulf of Mexico, along with a high spring frequency on the Louisiana coast, point to the trans-Gulf course followed by some individuals. Although the high frequencies of the Yellow-bellied Sapsucker on the northern Gulf coast may merely reflect its status there in winter, late individuals appearing there after the winter population has departed probably come from across the Gulf, some of them from the West Indies *via* the Dry Tortugas. The Red-headed Woodpecker (*Melanerpes erythrocephalus*), not included in this study because it is not known to winter south of the United States, occurs as a summer resident on islands off the Mississippi coast (Burleigh, 1944) and as a spring transient on Gulf islands off Florida (including a June record for the Tortugas; Howell, 1932).

TYRANNIDAE. The Eastern Kingbird has been cited (Williams, 1945) as a circum-Gulf migrant, and does appear to be unusually common on parts of the Texas coast. The lack of large numbers in Mexico, however, coupled with the earlier migration dates on

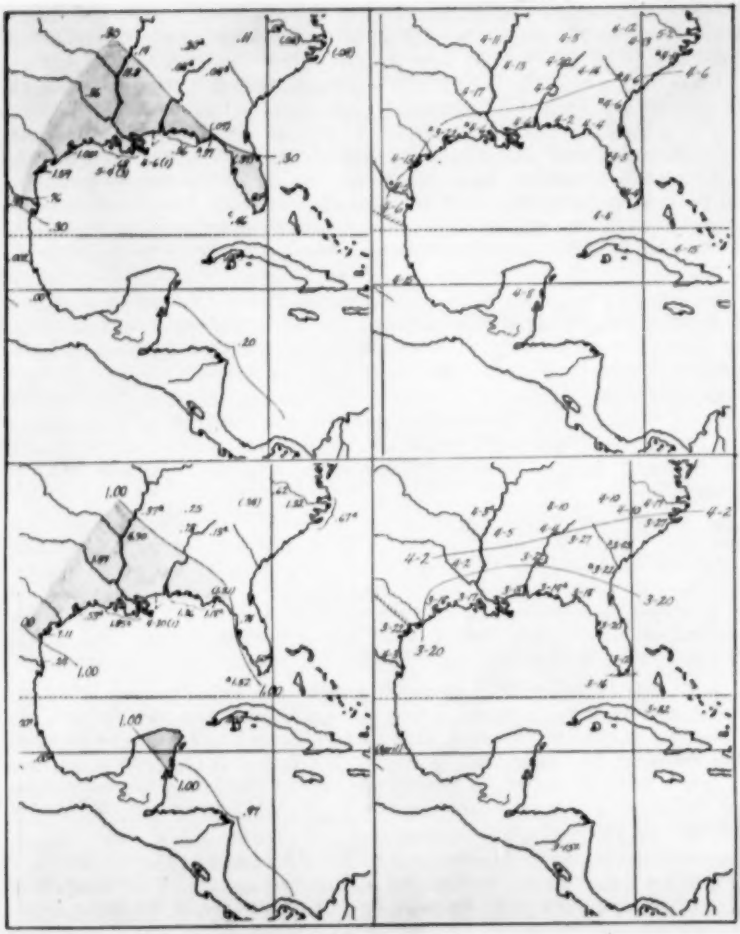

FIG. 19 (upper left) Comparative Abundance and FIG. 20 (upper right) Arrival Dates for the Common Nighthawk.

FIG. 21 (lower left) Comparative Abundance and FIG. 22 (lower right) Arrival Dates for the Eastern Kingbird.

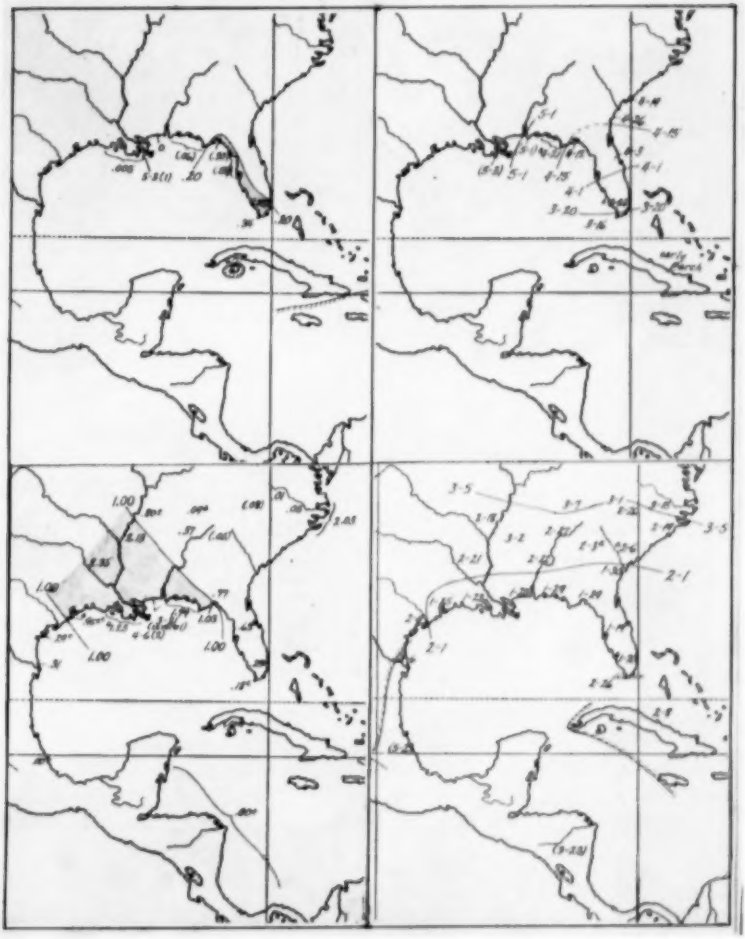

FIG. 23 (upper left) Comparative Abundance and FIG. 24 (upper right) Arrival Dates for the Gray Kingbird.

FIG. 25 (lower left) Comparative Abundance and FIG. 26 (lower right) Arrival Dates for the Purple Martin.

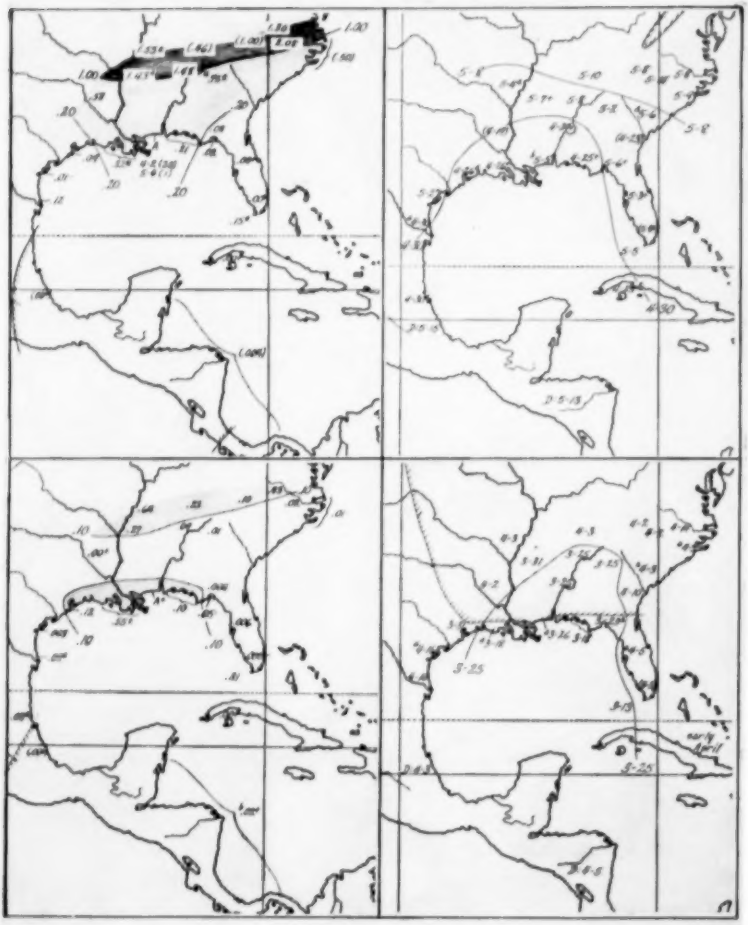

FIG. 27 (upper left) Comparative Abundance and FIG. 28 (*lower* right) Arrival Dates for the Wood Thrush.

FIG. 29 (lower left) Comparative Abundance and FIG. 30 (*upper* right) Median Dates for the Olive-backed Thrush.

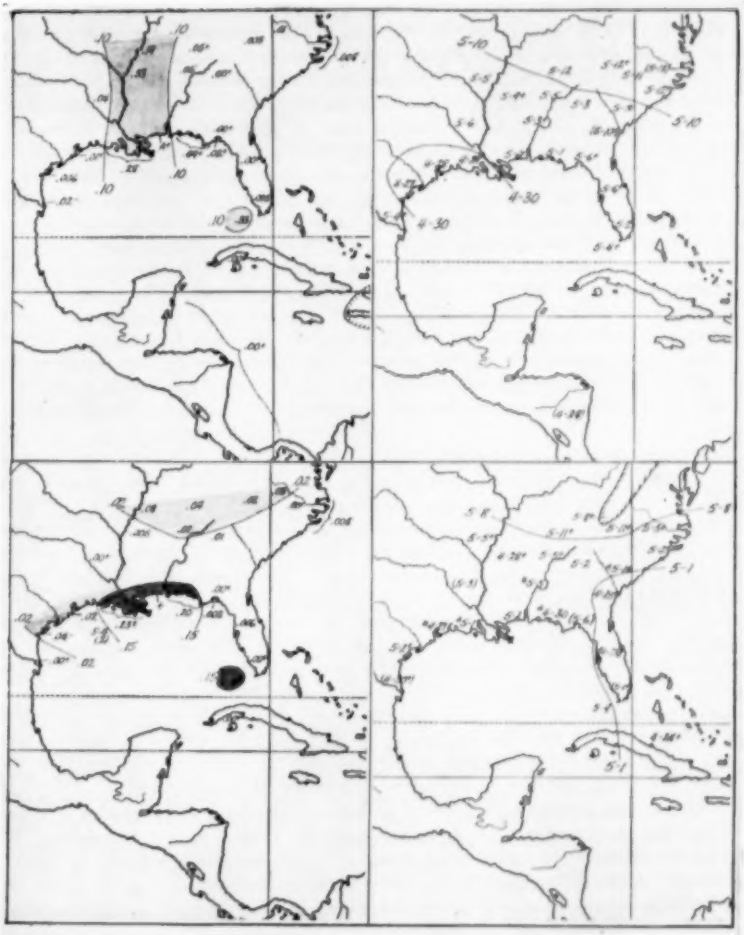

FIG. 31 (upper left) Comparative Abundance and FIG. 32 (upper right) Median Dates for the Gray-cheeked Thrush.

FIG. 33 (lower left) Comparative Abundance and FIG. 34 (lower right) Median Dates for the Veery.

the northern Gulf coast convince me that the chief migration route is across the western Gulf (Figs. 21 and 22). On the contrary, the occurrence of a Gray Kingbird over the Gulf of Mexico (Lowery, 1946) is considered most unusual (Figs. 23 and 24). At present there is no evidence of Gulf-crossing for the Western Kingbird or Scissor-tailed Flycatcher, but it may be expected occasionally. Despite its seeming absence from the Dry Tortugas, the Crested Flycatcher must be considered a trans-Gulf migrant, arriving early on the northern Gulf and being most common in spring from northern Florida to the Mississippi coast. Although there is a spring record of the Eastern Phoebe off the Louisiana coast, its scarcity south of the Gulf in winter makes this occurrence appear unusual. Members of the genus *Empidonax*, difficult to separate in the field, are quite common in spring in eastern Mexico and southern Texas. A record of one on the Gulf, however, as well as early arrival dates of the Acadian and Least flycatchers on the northern Gulf coast, demonstrates that a trans-Gulf passage of these small birds may not be unusual. Two species of pewees occur in spring in eastern Mexico and southern Texas, and identification of silent birds is impossible without collecting. Nevertheless, the highest frequencies and the earliest records are along the northern Gulf coast, leading to the belief that the Eastern Wood Pewee is chiefly a trans-Gulf migrant. Not enough data are available for the Olive-sided Flycatcher to be indicative.

HIRUNDINIDAE. Although the major flight of Tree Swallows passes along the sides of the Gulf, the data suggest that at least a few cross it in spring. Bank Swallows are both trans-Gulf and circum-Gulf migrants, the greatest numbers occurring on the Texas and Louisiana coasts. Early arrival dates show the Rough-winged Swallow to cross the Gulf regularly, although none has been reported offshore; also the numbers reported in eastern Mexico have been comparatively small. Even though Barn Swallows follow parts of the coastline in great numbers, the following facts persuade me that a major flight crosses the Gulf: earliest median dates in Texas and Louisiana; frequencies on the Texas coast several times as high as those in eastern Mexico; at least eight spring records involving hundreds of individuals on the open Gulf. Data for the Cliff Swallow are similar to those for the Barn Swallow, except that there is a progression of migration dates around the Texas and Louisiana coasts; therefore it is probable that most individuals follow at least this part of the coastline, but a few precocious migrants have been seen offshore from Louisiana to Alabama. All three lines of evidence favor the theory that Purple Martins are Gulf-crossing migrants (Figs. 25 and 26).

TROGLODYTIDAE AND MIMIDAE. There is no evidence of a trans-Gulf migration of House Wrens, and their northerly winter range would not suggest such a probability. The two heaviest flights of Catbirds are across the Gulf and northward on the Florida Peninsula, with a fair migration also through eastern Mexico.

TURDIDAE. Members of this family are among the most typical of the trans-Gulf migrants, although the northerly winter ranges of the Robin and Hermit Thrush militate against their total contribution to this phenomenon. The Wood, Olive-backed, and Gray-cheeked thrushes, and the Veery are much more numerous in spring on the Dry Tortugas and the northern Gulf than in peninsular Florida, Texas, or eastern Mexico; this evidence is fully backed by the sequence of migration dates and by sight records of three of these species on the open Gulf (Figs. 27–34).

SYLVIIDAE. Frequencies of the Blue-gray Gnatcatcher are too irregular to be of value in this study, but the progression of arrival dates implies only circum-Gulf migration. Essentially the same situation holds for the Ruby-crowned Kinglet, which is probably rare south of the Gulf of Mexico even in winter.

MOTACILLIDAE AND BOMBYCILLIDAE. Although there is little *prima facie* evidence for Gulf-crossing in the American Pipit, it is unlikely that the occasional individuals seen on the northern Gulf coast in early May have circled part of the Gulf or lingered so far past the species' normal departure date. Similarly, I am suspicious of large flocks of Cedar Waxwings seen on the northern Gulf coast in spring where they have been chiefly absent in winter.

VIREONIDAE. The White-eyed Vireo is a difficult subject due to its extensive winter and summer ranges, but early arrival dates on the northern Gulf coast suggest that a part of the migration comes across that body of water. Earliest records of Bell's Vireo also extend northeastward from Corpus Christi, Texas, although there is certainly an important migration through eastern Mexico. Yellow-throated Vireos have proven more common in spring along the Gulf from northern Florida to Galveston Bay than farther south, even though most of the former area lies south of its breeding range. It is very likely that there are smaller migrations along the Texas coast and Florida Peninsula. My data on the Blue-headed Vireo are inconclusive, but the Red-eyed Vireo is, without doubt, chiefly a trans-Gulf migrant (Figs. 35 and 36). The Philadelphia Vireo migrates across the Gulf mostly to the Texas coast, and the Warbling Vireo is about equally frequent there and in Louisiana. Probably a few individuals of the latter species follow the coast northward from Mexico.

PARULIDAE. Records of birds on the Gulf and early median dates in Mississippi and Louisiana are signs of a trans-Gulf migration of the Black and White Warbler. Comparative frequencies, however, show the migration on both sides of the Gulf to be just as important. The absence of the Prothonotary Warbler in eastern Mexico and its scarcity in the southern Florida Peninsula leave no room for doubt that it migrates chiefly across the Gulf, as has long been claimed. The sequence of arrival dates and records over the Gulf complete the evidence (Figs. 37 and 38). Present evidence favors the same view for Swainson's Warbler, although it is so rare at some places on the northern Gulf coast that the significance of quantitative data are open to question. The trans-Gulf and circum-Gulf highways are utilized about equally by the Worm-eating Warbler, but the Golden-winged and Blue-winged warblers evidently cross from Central America to Texas and Louisiana in greatest numbers. Early spring records of Bachman's Warbler in Louisiana and Mississippi suggest a direct flight from Cuba, but data are too scarce to be conclusive. Most Tennessee Warblers fly directly from their winter home to (or beyond) the shoreline stretching from Texas to Alabama, but a smaller migration passes through eastern Mexico (Figs. 39 and 40). It does not appear geographically probable that many Orange-crowned Warblers would cross the Gulf of Mexico in spring, nor is there direct evidence that they do so. Most Nashville Warblers reach the Texas coast from eastern Mexico, but a few apparently take a short cut from Yucatan to points as far east as Louisiana. Although the major migration of Parula Warblers passes through the Florida Peninsula, many individuals cross from Yucatan (and Cuba?) to the northern Gulf as far west as Galveston Bay. The principal migration routes of the Yellow Warbler extend up the Mexican-Texas coast and across the western Gulf. The statement that it is "less numerous in spring" than in fall in Florida (Howell, 1932) is extremely conservative, as it is decidedly rare in the Peninsula at that season. The case of the Magnolia Warbler is similar, but it is even scarcer in Florida. Notwithstanding the fact that the Cape May Warbler is a regular transient in peninsular Florida, it appears that a fairly important part of its spring flight carries northwestward across southern Florida and the eastern Gulf to northwestern Florida, coastal Alabama, and inland localities. This helps to explain the presence of a few on the open Gulf

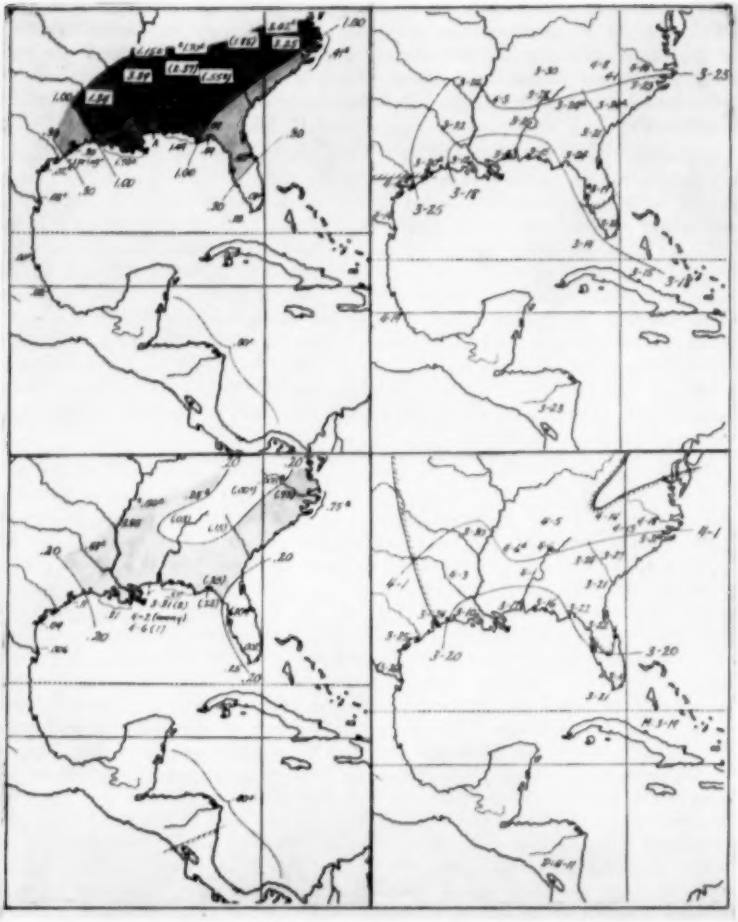

FIG. 35 (upper left) Comparative Abundance and FIG. 36 (upper right) Arrival Dates for the Red-eyed Vireo.

FIG. 37 (lower left) Comparative Abundance and FIG. 38 (lower right) Arrival Dates of the Prothonotary Warbler.

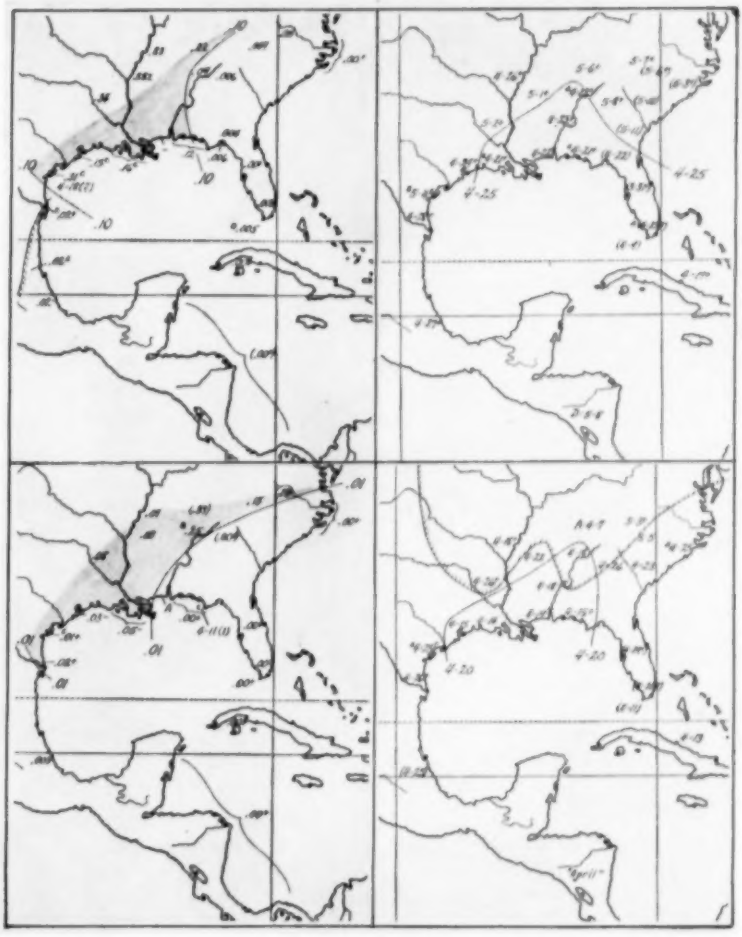

FIG. 39 (upper left) Comparative Abundance and FIG. 40 (upper right) Median Dates for the Tennessee Warbler.

FIG. 41 (lower left) Comparative Abundance and FIG. 42 (lower right) Median Dates for the Cerulean Warbler.

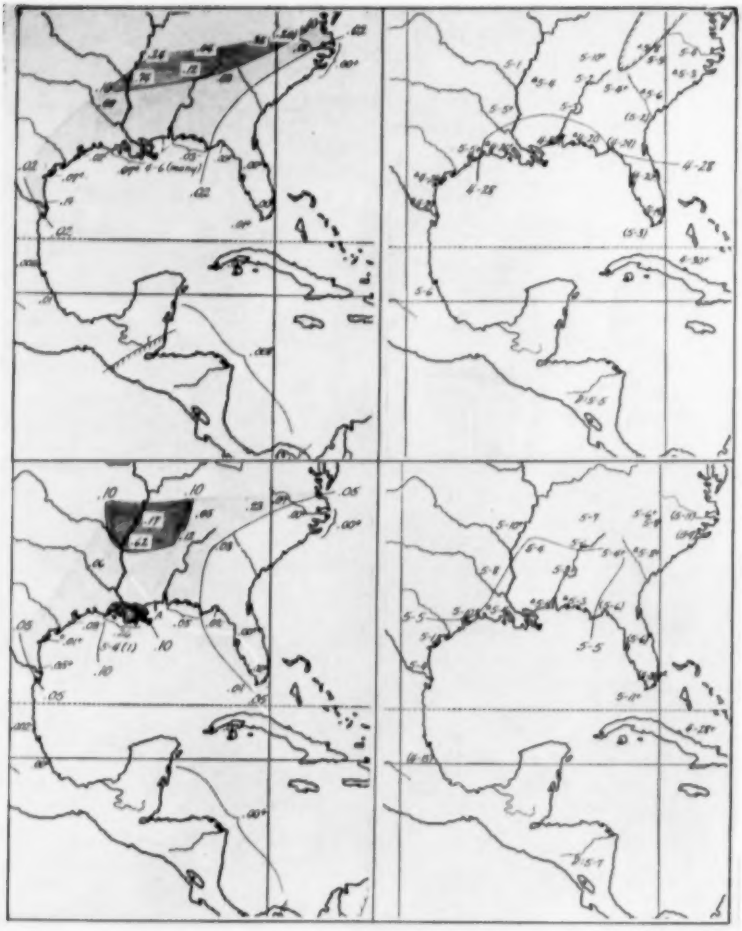

FIG. 43 (upper left) Comparative Abundance and FIG. 44 (upper right) Median Dates for the Chestnut-sided Warbler.

FIG. 45 (lower left) Comparative Abundance and FIG. 46 (lower right) Median Dates for the Bay-breasted Warbler. .

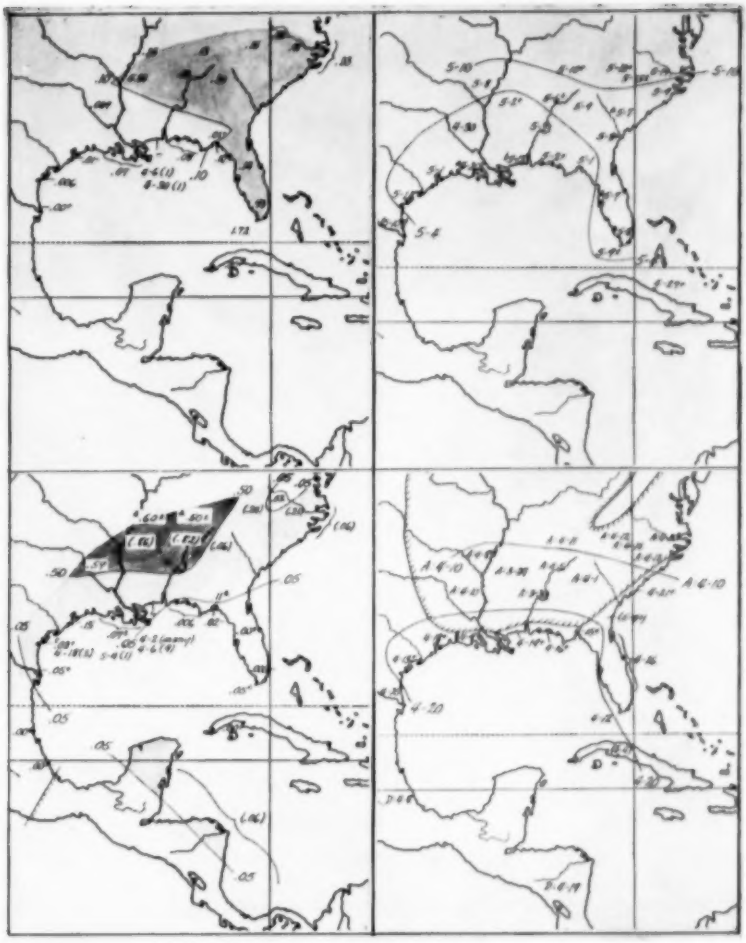

FIG. 47 (upper left) Comparative Abundance and FIG. 48 (upper right) Median Dates of the Black-poll Warbler.

FIG. 49 (lower left) Comparative Abundance and FIG. 50 (lower right) Median Dates for the Kentucky Warbler.

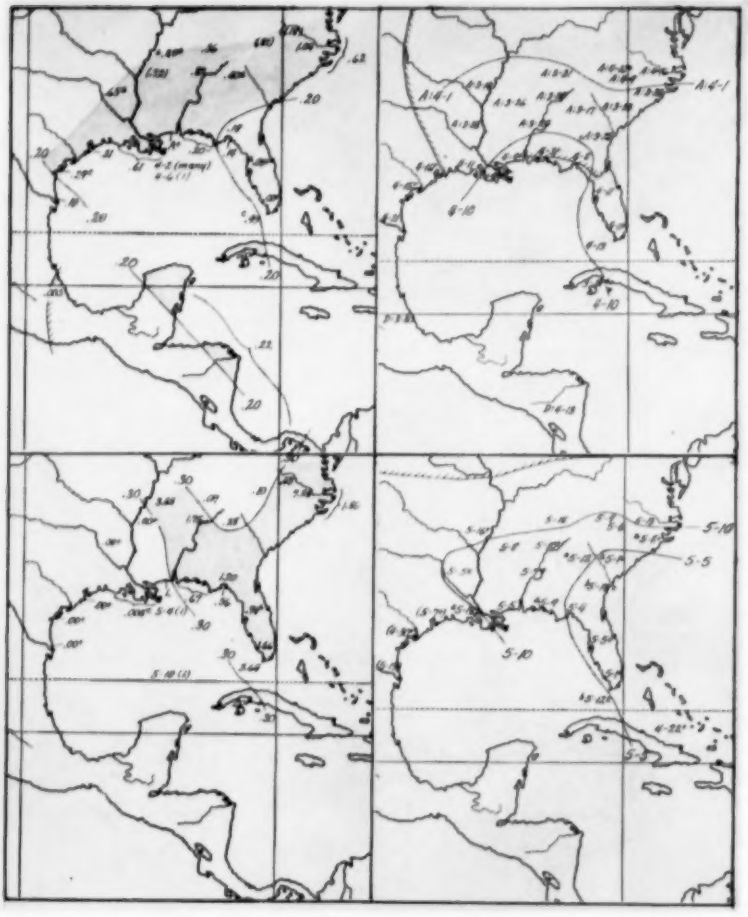

FIG. 51 (upper left) Comparative Abundance and FIG. 52 (upper right) Median Dates for the Hooded Warbler.

FIG. 53 (lower left) Comparative Abundance and FIG. 54 (lower right) Median Dates for the Bobolink.

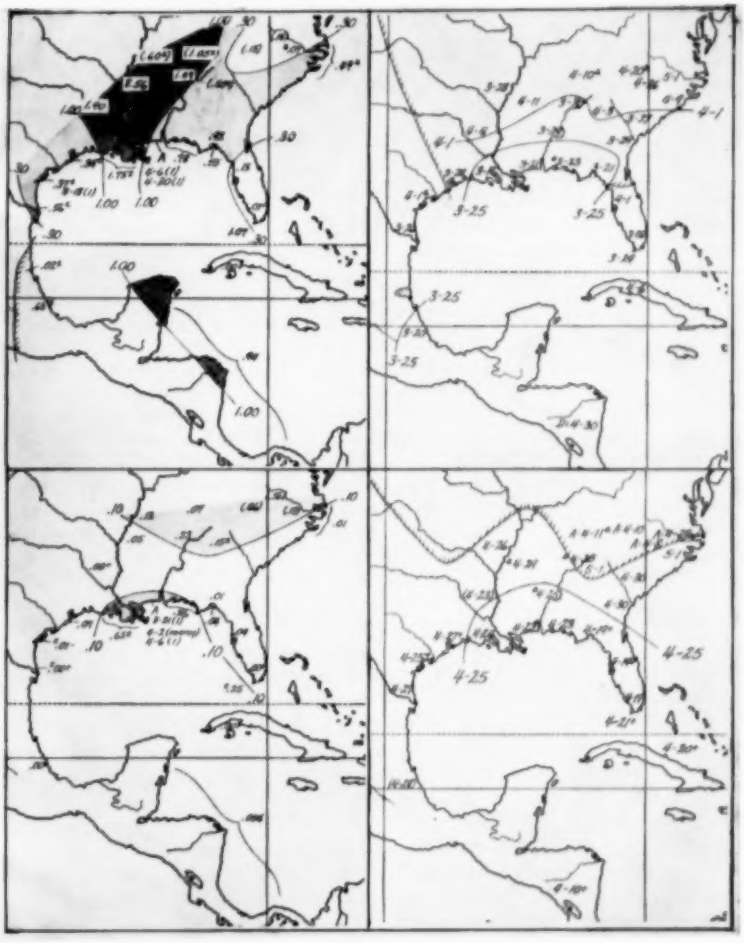

FIG. 55 (upper left) Comparative Abundance and FIG. 56 (upper right) Arrival Dates for the Orchard Oriole.

FIG. 57 (lower left) Comparative Abundance and FIG. 58 (lower right) Median Dates for the Scarlet Tanager.

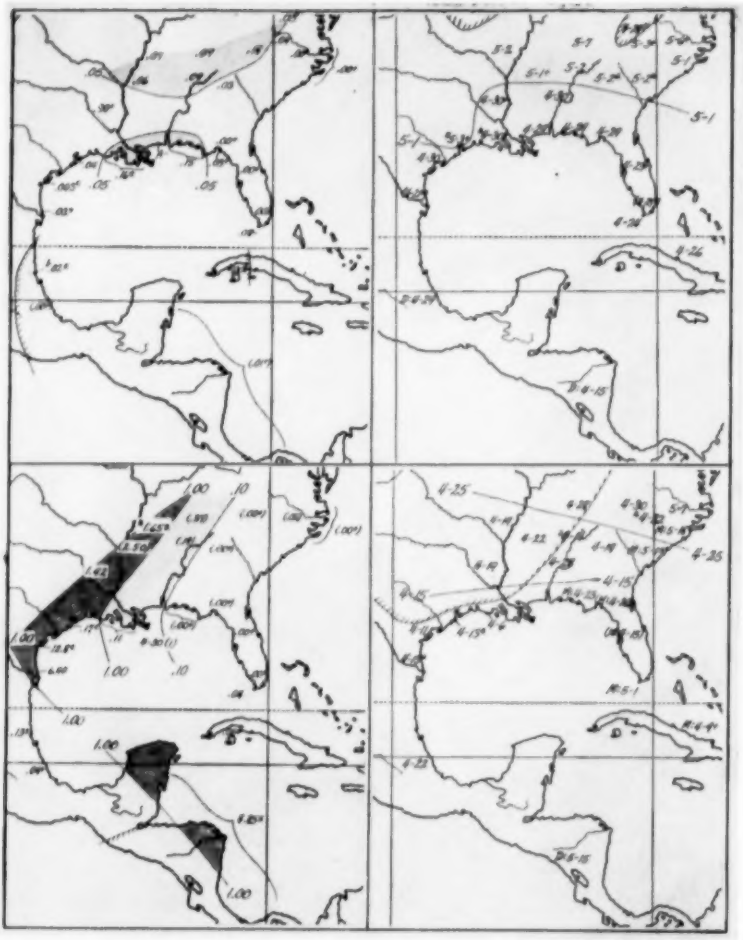

FIG. 59 (upper left) Comparative Abundance and FIG. 60 (upper right) Median Dates for the Rose-breasted Grosbeak.

FIG. 61 (lower left) Comparative Abundance and FIG. 62 (lower right) Arrival Dates for the Dickcissel.

(Lowery and Newman, 1954). The migration of the Black-throated Blue Warbler is much more nearly confined to the Florida Peninsula, very few venturing across the Gulf. Conclusive evidence on the commonly-wintering Myrtle Warbler is difficult to obtain, but its quantitative distribution in spring and records on the Gulf denote trans-Gulf flights with an occasional straggler near the middle of May. The Black-throated Green Warbler may be the only eastern member of its genus to migrate chiefly through eastern Mexico, but a few also cross the Gulf in spring. Cerulean (Figs. 41 and 42) and Blackburnian warblers precipitate on the Texas and Louisiana coasts, only small numbers occurring in eastern Mexico; their median dates are also earlier on the northern Gulf coast. Early arrivals on the northern Gulf and a record 60 miles off the Louisiana coast (Bullis and Lincoln, 1952) signify a trans-Gulf passage for the Yellow-throated Warbler, but it is possible that migrations through Mexico and the Florida Peninsula are equally heavy. The trans-Gulf migration of Chestnut-sided and Bay-breasted warblers brings the largest numbers to that part of the coast lying between southern Texas and extreme western Florida (Figs. 43–46). The spring migration of the Black-poll (Figs. 47 and 48) and Prairie warblers is very similar to that described for the Cape May, except that many more precipitate on the southern Atlantic coast. Trans-Gulf migration for the rare Kirtland's Warbler is geographically most unlikely. With the probable exception of a small per cent of its total population, the Palm Warbler appears not to cross the Gulf in spring. The Oven-bird migrates on a broad front, but perhaps the most important flight crosses the Gulf (some northwestward?) to the stretch of coast from Galveston Bay to Pensacola, Florida. Essentially the same statement applies to the Northern Water-thrush, but the Louisiana Water-thrush converges (appropriately enough) mainly on the Louisiana coast. The northern and western Gulf receives the greatest numbers of Kentucky Warblers in spring, eastern Mexico and the Florida Peninsula apparently having but few (Figs. 49 and 50). The Connecticut Warbler is so rare that a dogmatic statement of its main migration route would be foolhardy, but there is no evidence that it concentrates on any major part of the southeastern United States. Mourning Warblers pass northward mainly along the Mexico-Texas coast and the record of "many" 30 miles off the Louisiana coast on the early date of April 2 (Frazar, 1881) is very surprising, to say the least. The Yellow-throat is a permanent resident along the Gulf coast, and the only definite clue to its migration route is the fact that numbers have been seen on the open Gulf on four occasions. It is possible that its migration on the sides of the Gulf is equal in volume. Most Yellow-breasted Chats move into the eastern United States through Mexico and Texas, but the likelihood that a few make the Gulf transit in spring should not be overlooked. The Hooded Warbler is a striking example of a trans-Gulf migrant, despite the fact that only two offshore records are known (Figs. 51 and 52). Many Wilson's and Canada warblers travel up the Mexico-Texas coast in spring, but there is evidence that some fly directly from Central America to Louisiana. The heaviest movements of American Redstarts are up the Florida Peninsula and across the central and western Gulf, with eight records on the Gulf.

ICTERIDAE. Although the Bobolink has frequently been mentioned as an example of a Florida Peninsula migrant, it was found in this study to occur most frequently on the Dry Tortugas and to be fairly common as far west as the Alabama coast. Taken in conjunction with three records on the Gulf, this leaves little doubt of Gulf-crossing by some individuals (Figs. 53 and 54). Both eastern species of orioles unquestionably follow trans-Gulf routes to a large extent, their center of abundance comprising the coasts of Texas and Louisiana (Figs. 55 and 56).

THRAUPIDAE. Tanagers are classic examples of trans-Gulf migrants. Most of the Scarlet Tanagers cross the coast line of Louisiana, Mississippi, and Alabama (Figs. 57 and 58), but the wider-ranging Summer Tanager is about equally common from northern Florida to Galveston Bay.

FRINGILLIDAE. Rose-breasted Grosbeaks are most numerous on the same parts of the Gulf Coast as Scarlet Tanagers, and the two species usually occur in the same waves (Figs. 59 and 60). Apparently the Blue Grosbeak is chiefly a trans-Gulf migrant, but there is great variation in abundance from one region to the next, and the values in eastern Mexico are not so low as for many other migrants. Available evidence points to a route across the western Gulf for the Indigo and Painted buntings, but in each case their status in eastern Mexico is somewhat uncertain. Dickcissels have not been recorded in eastern Mexico in numbers comparable to those on the Texas coast, and many are believed to take a shorter route from the Yucatan Peninsula to Texas (Figs. 61 and 62). There is little or no evidence for a trans-Gulf migration of the five species of sparrows included in this study (Savannah, Grasshopper, Lark, White-crowned, and Lincoln's), except for one record of the Grasshopper Sparrow on the open Gulf (Brooks, 1922).

Comparisons with Fall Migration

Although the subject of the coastal hiatus of spring transients has been adequately characterized and analyzed (Lowery, 1945; Williams, 1950), I know of no quantitative data which have been cited in support of this phenomenon. Numerical records of birds seen on field trips in the Tallahassee, Florida, region from September, 1946, through May, 1955, reveal some significant differences between the spring and fall migrations. Data in the fall of 1954 were omitted from the Leon County totals in order to equalize the amounts of time afield in spring (March through May) and fall (July through November), justifying numerical comparisons of the species considered. These figures, presented in Table 4, characteristically show greater contrast inland than on the coast for most species.

General Conclusions

Evidence bearing on the migration routes of spring migrants was adduced from direct observation, comparative abundance around the Gulf of Mexico, and the sequence of migration dates. Each line of evidence indicated that both the circum-Gulf and trans-Gulf routes are commonly utilized in spring. Approximately 40 species of summer residents, winter residents, and transients were found more frequently along the northern Gulf coast (exclusive of Texas) than on its eastern and western sides. Many species, however, were much less frequent there in spring than in fall, validating the theory of the coastal hiatus (Lowery, 1945). The larger numbers of species and individuals on the Texas coast are due to the fact that it makes up a part of both the trans-Gulf and circum-Gulf migration routes. It is thought prob-

TABLE 4

COMPARISONS OF NUMBERS OF BIRDS SEEN IN THE TALLAHASSEE, FLORIDA, REGION IN SPRING AND FALL, 1946-55

	Leon County (Inland) Spring	Fall	Coastal Counties Spring	Fall
Number of parties	5	5	12	10
Total hours in field	388	388	470	481.5
Species:				
Bank Swallow	3	116	7	46
Barn Swallow	56	536	305	1488
Cliff Swallow	—	2	—	5
Catbird[1]	6	67	90	267
Olive-backed Thrush	1	4	15	4
Gray-cheeked Thrush	—	2	7	4
Veery	—	19	1	12
Golden-winged Warbler	—	11	—	5
Blue-winged Warbler	1	4	2	4
Tennessee Warbler	1	73	2	16
Yellow Warbler	1	33	13	88
Magnolia Warbler	—	29	4	48
Black-throated Green Warbler	1	35	4	10
Cerulean Warbler	—	23	—	4
Blackburnian Warbler	—	47	3	21
Chestnut-sided Warbler	—	44	—	27
Bay-breasted Warbler	—	9	6	15
Northern Water-thrush	7	30	6	24
Hooded Warbler[2]	61	268	59	251
American Redstart	6	73	7	142
Scarlet Tanager	4	6	13	4
Rose-breasted Grosbeak	—	8	10	5

[1]A few are present in winter, especially near the coast.
[2]A few are present in summer.

able that most individual land birds tend to follow a direct route from their wintering grounds to their breeding grounds, but may be carried off course by strong winds. Therefore a part of the supposed coastwise migration in Texas and Florida may have begun as a trans-Gulf migration.

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Department of Biological Sciences, Florida State University, Tallahassee, Florida, March 20, 1956

SOME OBSERVATIONS ON SUN-BATHING IN BIRDS

BY DORIS C. HAUSER

THE effect of the sun on passerines and other terrestrial birds is a subject about which little has been written. Voluntary sun-bathing, accompanied by preening, surely has been observed widely but the details seldom have been recorded for the benefit of those interested in all phases of bird behavior. Therefore, it seems worthwhile to report my observations of sunning behavior which have been gathered over a number of years.

From the end of March, 1954, until August 20, 1954, in Gainesville, Florida, and thereafter at Fayetteville, North Carolina, I have observed and recorded in sun-bathing attitudes, hundreds of individual birds of 33 different species. These records suggest that there are two reasons for the assumption of the characteristic posture:

1. Voluntary, or normal sun-bathing; an attitude assumed by a bird apparently for reasons of health and well-being, accompanied by preening, shaking, scratching and repeated resumption of the sun-bathing posture.
2. Compulsory Sun Position, the same attitude assumed when a bird is suddenly and apparently unexpectedly exposed to direct sunlight, under more or less extreme conditions of humidity and heat. This response may be accentuated by the physiological condition of the bird; and it appears to be unpremeditated and irresistible. Upon recovery the bird usually flies immediately to shade.

VOLUNTARY SUN-BATHING IN SONGBIRDS

On April 17, 1952, I saw a Brown Thrasher (*Toxostoma rufum*), in full sun, deep in the soft, dry sand of our driveway in Gainesville, Florida. Breathing heavily, with its bill wide open, the bird's head had fallen back as though it were suffering and dying. The body feathers were ruffled and the tail and wings spread into full fans, but as I approached closer the thrasher recovered completely and flew into the brush.

Since witnessing that incident, I have seen birds sun-bathing from Maine to Texas and, although some species differ slightly in their posture, the general pattern is much the same.

It is recognized that many birds expose themselves to the rays of the sun, fluffing out their feathers and leaning to one side, immobile, and then ruffling and preening. The specific good they derive from such behavior is not definitely known. It has been suggested that birds fluff their feathers to remove parasites by exposing them to the sun or to dust. Some authorities, notably Hou (1929, cited by Kendeigh, 1934) believe that there is a connection

between the use of the preen gland and the proper effect of irradiation. Dr. Herbert Friedmann wrote me (June, 1954) that he had experimented with the secretion of the preen gland: "The secretion, when rubbed on the feathers and subsequently exposed to sunlight and then inadvertently swallowed by the bird when preening its plumage, is a source of Vitamin D."

It appears, from my observations, that the previous weather conditions often have a great deal to do with sun-bathing. A rainy spell or several dark days, followed by strong sunlight appear to accelerate the need for the sun's rays and will bring many birds out to bask in the sun and to preen. However, Miller (1952) reported sun-bathing in House Finches (*Carpodacus mexicanus*) under conditions of low relative humidity and high summer temperature in California and my records include many incidents of voluntary sun-bathing in hot, dry periods.

In addition, it appears that there is a social quality in sun-bathing; that a single bird in the Voluntary Sun Position attracts the attention of other birds, which join the first and also sun-bathe. These may be of the same or of a different species. Another factor rests in the use of a particular site for repeated sun-bathing, day after day and month after month. In my yard in Florida during 1954 dozens of birds of different species sun-bathed in my pear tree; at present, in Fayetteville, North Carolina, a fallen but still verdant pecan tree is the community sun bath. When sunshine follows a heavy rain, I can see from 10 to 30 birds of six or more species sun-bathing in that single tree.

Young birds are seen sun-bathing more frequently than adults except during the late summer molting season when many adult birds in all stages of molt may be seen preening and sunning.

Sun-bathing patterns of some perching birds are described below:

At 1:20 p.m. on May 7, 1954, a female Cardinal (*Richmondena cardinalis*) was observed in full Sun Position on the ground. Its bill was slightly open, head and body at a 50-degree lean to the right, body feathers fully fluffed; then it leaned even further to the right. The bird changed its position from facing the sun to placing its left side to the sun. Preening briefly, the bird then flew to the pear tree after about five minutes in the sun.

The earliest morning record of voluntary sun-bathing was that of a female Cardinal in heavy molt at 7:30 a.m. on August 4, 1954. With only one full-length feather in its crest and three in its tail, the ragged-looking bird spent fully 15 minutes sun-bathing in the early morning sun. The bird first faced the sun and then turned with its back to the sun, assuming the full Sun Position after each lengthy period of preening during which it appeared to work its bill along every one of its feathers.

August 12, 1954, at 11:50 a.m., a young female White-eyed Towhee (*Pipilo erythrophthalmus*) came to the water pan to bathe fully with House Sparrows (*Passer domesticus*) three or four times. Then it flew to a spot on the ground, in full sun, beside the wax myrtle hedge. In company with six or eight sparrows, already in different stages of sun-bathing, the towhee preened, fluffed its feathers and shook its body for five minutes; then it settled low in a modified sun-bathing position with crown feathers raised, bill

open, and body and head leaning to one side but without the body feathers being fully fluffed. The bird alternately preened and resumed the sunning pose. A young Blue Jay (*Cyanocitta cristata*) flew down and settled by the towhee and assumed the sun-bathing position, with crest raised high, body feathers fully fluffed, and wings and tail fanned, leaning to one side with its bill open for 30 seconds, and then flew away. A second young jay dropped down for a brief sun bath with the sparrows and towhee. The sparrows were changing constantly, with new sun-bathers taking the places of those which left.

Of the order Piciformes, I have seen the Flicker (*Colaptes auratus*), the Red-bellied Woodpecker (*Centurus carolinus*) and the Golden-fronted Woodpecker (*C. aurifrons*) of Texas in sun-bathing attitudes. The latter two birds use telephone poles as well as trees in full sun for their sun-bathing perches.

April 25, 1954, at 9.00 a.m., a Red-bellied Woodpecker was making loud "kraaaak" calls from the top of a telephone pole. After three or four calls, it would preen and ruffle its feathers and call again. The bird repeatedly pecked into the top of the post, digging its bill then into its feathers all over its body and wings, back and front. Then it waddled over 12 inches to the top of the cross-bar of the pole where it continued to preen and call and stretch its wings. Next the bird spread itself out into full Sun Position, with crown feathers raised, head cocked to one side, bill open, with the upper eye staring at the sun. Staying thus only briefly, the woodpecker would get up to preen, stretch, call, and change position on the cross-bar, probably half a dozen times. At one change, the bird straddled the cross-bar with its wings hanging down at either side, full fanned, and its tail spread wide and the crown feathers raised.

The Ground Dove (*Columbigallina passerina*) differed from most species in that it never leaned far to one side nor opened its bill, despite the length of its stay in the full sun; and it also was the only bird which blinked its eyes throughout the sunbath.

May 1, 1954, at 11:30 a.m., a Ground Dove sun-bathed at what later proved to be a favorite spot, on a heap of drying magnolia leaves. The bird preened lengthily with its rump feathers raised high while preening the wings. Turning to face different directions after each brief period of preening and sunning, it spread its wings and made a partial fan of its tail and, raising the crown and body feathers, stood immobile but still blinking. The dove's sunbath lasted for 15 minutes.

The month of June, 1955, in Fayetteville, had been extraordinarily cool, rainy and overcast, with only a few hot days and very little sun. On June 25, a day with moderate to fresh breezes and an air temperature of 90° F., I verified the site of a second sun-bathing location, having earlier seen many species flying into this place. The site was a compost heap, primarily composed of decaying elm leaves, in a corner of the yard just below the fallen pecan mentioned earlier, and well secluded by shrubs and high grasses. No birds were sun-bathing on the pecan, probably because of the breezes. Onto this heap, from 1:30 to 3:00 p.m., when the sun was free of the drifting clouds, I watched three Crested Flycatchers (*Myiarchus crinitus*), two Tufted Titmice (*Parus bicolor*), three Blue Jays, Catbirds (*Dumetella carolinensis*), Cardinals and House Sparrows approach via a perch on the pecan tree, then

onto the fence, and finally down to the leaf bed. Here they immediately assumed the Voluntary Sun Position, and in each of the birds, the attitude was so exaggerated that I returned to the house for a Taylor candy thermometer, which registered 140° F. when laid on the leaf bed in the full sun.

None of the birds preened at this site but, having exposed themselves to the sun for one to three minutes, they flew to shade with bills still open, panting. I believe that some, if not all, flew down to bathe at the creek after the sunbath, but heavy brush made it impossible to follow any individual bird with my glasses although the creek is not over 40 feet from the leaf bed.

Figure 1 (inset 6) illustrates a Mockingbird (*Mimus polyglottos*) in an exaggerated sun-bathing pose, with the neck so stretched and twisted that its under side is uppermost. A Brown Thrasher was also recorded in this posture on May 5, 1954, at 3:00 p.m., after a heavy rain when the sunshine was clear and intense. While remaining fully fluffed, with wings and tail fanned, the thrasher raised its head 6 or 8 times, when alarmed, and then leaned again to turn its head over completely and continue its sunbath.

The species which have been observed in Voluntary Sun-bathing Position are listed in Table I. Only three species, the Brown Thrasher, Carolina Wren (*Thryothorus ludovicianus*), and House Sparrow, have been seen taking sand-baths in connection with the sun-bathing.

Certain questions arise with reference to the Voluntary Sun-bathing:

1. How can a bird so expose its eye, and then, on turning the head, expose the other eye to the direct rays of the sun, without damage? Is it possible that the eye does absorb some ultra-violet rays when so directly exposed?

2. Does the voluntary exposure of the bird to full sun stimulate the preen gland to manufacture and/or produce oil for dressing the plumage? When a bird is in sun-bathing position with its back to the sun, the feathers at the rump are raised so high that they fully expose the naked preen gland.

3. Do continuous days without sun deprive a bird of necessary irradiation, especially in the case of young birds just recently out of the nest? Does a need of irradiation by the sun's rays explain the deliberate and voluntary exposure to intense heat, such as indicated by a reading of 140° F. on the compost leaf pile?

4. Do the external parasites to which birds are the hosts increase in numbers in damp, cool weather, making exposure to intense solar radiation more necessary following periods of cloudy weather?

Compulsory Responses to the Sun

In January, 1954, at my home in Gainesville, Florida, I replaced an old bread tin, which had served as a window feeder, with a brown masonite tray measuring 18 by 22 inches. The window faced due south and for about

TABLE 1

SPECIES OBSERVED IN VOLUNTARY SUN-BATHING POSITION

Green Heron (*Butorides virescens*)
Royal Tern (*Thalasseus maximus*)
Mourning Dove (*Zenaidura macroura*)
Ground Dove (*Columbigallina passerina*)
Flicker (*Colaptes auratus*)
Red-bellied Woodpecker (*Centurus carolinus*)
Golden-fronted Woodpecker (*Centurus aurifrons*)
Crested Flycatcher (*Myiarchus crinitus*)
Wood Pewee (*Contopus virens*)
Blue Jay (*Cyanocitta cristata*)
Tufted Titmouse (*Parus bicolor*)
Carolina Wren (*Thryothorus ludovicianus*)
Mockingbird (*Mimus polyglottos*)
Catbird (*Dumetella carolinensis*)
Brown Thrasher (*Toxostoma rufum*)
Robin (*Turdus migratorius*)
Starling (*Sturnus vulgaris*)
Red-eyed Vireo (*Vireo olivaceus*)
Yellow Warbler (*Dendroica petechia*)
Myrtle Warbler (*Dendroica coronata*)
American Redstart (*Setophaga ruticilla*)
House Sparrow (*Passer domesticus*)
Summer Tanager (*Piranga rubra*)
Cardinal (*Richmondena cardinalis*)
Common Goldfinch (*Spinus tristis*)
White-eyed Towhee (*Pipilo erythrophthalmus*)
White-throated Sparrow (*Zonotrichia albicollis*)

four hours during the day this tray was exposed to the sun's rays continuously. Birds had fed at this tray from dawn until dusk each day throughout the winter, as well as at the eight other feeders in the yard, all of which were in full or partial shade.

On March 25, 1954, a Myrtle Warbler (*Dendroica coronata*) alighted on the window feeder. It fluffed out all its head and body feathers, fanned its wings and tail and, leaning its head far to one side, appeared briefly to be in a coma. There was an accidental quality about the assumption of the posture which I had not previously noticed in birds which sun-bathed, since it began and proceeded quickly to its climax even as the bird was reaching for food.

In the next three weeks, a period of exceptionally warm weather, my records showed more sun-bathing incidents than in the preceding three years, all but three taking place on or near the feeding tray. The repetition of incidents, combined with what appeared to be an involuntary compulsion to fall into sun-bathing position (in which the birds appeared often to be in obvious discomfort), suggested that it was the compelling force of the sun which brought on this reaction. Furthermore, this sun-bathing was not observed on the tray earlier than 9:30 a.m., (a Myrtle Warbler), nor later than 1:45 p.m., (an Orange-crowned Warbler, *Vermivora celata*). The intervening hours corresponded with the period during which the window feeder was in direct sunlight.

Early records seemed to indicate that the birds suffered from some form of "heat prostration" because of the immediacy of the reaction to the sun

(often within 30 seconds of landing on the tray) as well as the apparent discomfort of the bird. However, continued observation suggests that the Compulsory Sun Position may be a means of regulating the body temperature when the individual is suddenly exposed to the sun. Frequently the bird continues to manipulate a seed in its bill while its feathers are fully fluffed and the bird is leaning far to one side. With some birds, the response alternately is accentuated and subsides many times during the feeding period and before the bird flies to a shady spot; always the bird remains alert to any outside alarm and is able to fly away instantly.

The wild birds recorded in the following pages were under no controls except their own interest in the food always available at the feeding locations.

Several levels of response to the effect of the sun have been distinguished, and are enumerated as follows:

I. The crown feathers are elevated, the wings are dropped so that the tips of the feathers touch the ground, and the tail feathers are spread; then the bird flies away.

II. The crown is elevated, wings dropped, tail feathers spread and the body plumage is fluffed fully before bird leaves.

III. The crown is elevated, wings dropped, tail fanned, body plumage fluffed fully and the bird leans to one side and settles, with bill opened, and eyes open, the upper eye staring at the sun. This response may last from 15 seconds to two minutes or more, depending, in most cases, on outside influences. At no time has any bird become unconscious; all were alert and able to fly away at any alarm.

Position III may be alternated with a return to normal behavior during which the bird preens, scratches and feeds briefly and resumes Level III for as many as six or eight times before flying to shade.

IV. Exaggerated Sun Position—when the bird's wings flopped forward wildly and it gasped, as if for air, and fell flat and widespread on the tray or lawn. This posture was observed most often in young birds, notably in young Jays. Note: In the case of two adult Starlings (*Sturnus vulgaris*), the "lean" was forward, with neck arched and the bill touching the ground, both wings fanned and thrust far forward.

In May, 1954, I put a Taylor candy thermometer, which registers to 300° F., flat on the tray and took the readings recorded in some of the incidents which follow. I recognize the inaccuracy of the readings, which probably include the heat of the sun, air, tray, and reflected heat of the white brick wall, but I include these figures for their possible interest in comparison, and because they seem to indicate that heat, alone, is not the motivating factor. The birds recorded included Cardinals, Blue Jays, Brown Thrashers and Red-bellied Woodpeckers.

Degrees Fahrenheit	Level of Response		
	II	III	IV
105°—109°	3	1	–
110°—114°	3	4	1
115°—119°	13	5	1
120°—124°	3	3	1
125°—129°	–	7	–
130°—134°	15	5	2
135°—139°	7	2	1

A further indication that heat is not the primary factor lies in the realization that air temperatures as low as 55° F. and 60° F. did not preclude a response from some species, all of which are migratory: Myrtle Warbler, Slate-colored Junco (*Junco hyemalis*), White-throated Sparrow (*Zonotrichia albicollis*), and Purple Finch (*Carpodacus purpureus*).

Cloudless, humid days of still air and intense sun resulted in the greatest number of individual responses.

Responses of Permanent Resident Species

On April 12, 1954, at 10:55 a.m., at Gainesville, Florida, a female Cardinal flew to the tray and was visibly affected by the sun's rays as she fed. The crest was raised high, the body feathers fluffed out and the bill opened as the bird breathed heavily. The Cardinal jerked its body as a Myrtle Warbler perched briefly on the tray but remained in Level III. Other Myrtle Warblers, flying toward the tray, swerved away and flew to a nearby shrub. After two minutes, the Cardinal recovered and fed and flew off on the arrival of a male Cardinal.

Both male and female Cardinals, visiting during the sunny hours, were frequently affected in this manner, and before long most of them were confining their trips to the period when the tray was in shade. To those that did visit it in the sun, tray temperatures of 130° F. and above usually brought response II or III, except in the case of a female which was wet from a recent bath and did not respond at all.

On June 18, 1954, at 11:15 a.m., with the tray temperature 112° F., a female Cardinal gave me a further indication that the rays of the sun, rather than heat alone, caused the response. It was a very hot day, with intermittent breezes and clouds. The bird landed on the tray when the sun was behind a cloud and began to feed on sunflower seeds. Suddenly the sun came out, sharp and clear, and the bird went into Level III, still working the seed in its bill. The Cardinal appeared aware of a House Sparrow and a Blue Jay which landed on the tray, but it stayed leaning to one side with its plumage fully fluffed manipulating the seed. A cloud covered the sun and the bird resumed its normal sleekness and moved to the other side of the tray; the sun reappeared and the bird reassumed Level III; another cloud covered

TABLE 2

LEVELS OF RESPONSE OBSERVED IN COMPULSORY SUN-BATHING POSITION

Species	Level I	II	III	IV
Mourning Dove (*Zenaidura macroura*)			x	x
Flicker (*Colaptes auratus*)				x
Red-bellied Woodpecker (*Centurus carolinus*)	x	x		
Blue Jay (*Cyanocitta cristata*)	x	x	x	x
Tufted Titmouse (*Parus bicolor*)		x	x	
Carolina Wren (*Thryothorus ludovicianus*)			x	
Mockingbird (*Mimus polyglottos*)			x	
Catbird (*Dumetella carolinensis*)			x	
Brown Thrasher (*Toxostoma rufum*)		x	x	
Robin (*Turdus migratorius*)			x	x
Starling (*Sturnus vulgaris*)	x		x	x
Orange-crowned Warbler (*Vermivora celata*)		x	x	
Myrtle Warbler (*Dendroica coronata*)	x	x	x	
Ovenbird (*Seiurus aurocapillus*)		x		
House Sparrow (*Passer domesticus*)	x	x	x	x
Bronzed Grackle (*Quiscalus versicolor*)[1]			x	
Cardinal (*Richmondena cardinalis*)	x	x	x	
Purple Finch (*Carpodacus purpureus*)		x		
Common Goldfinch (*Spinus tristis*)			x	
Slate-colored Junco (*Junco hyemalis*)			x	
Chipping Sparrow (*Spizella passerina*)			x	
White-throated Sparrow (*Zonotrichia albicollis*)	x	x	x	

[1]Maine

the sun, and the Cardinal took on its normal appearance and left the tray. Within a minute it was back again, crest erect and body plumage fluffed in the bright sun. A second female Cardinal landed on the tray and both uttered sharp "chick" sounds, as the first bird fluttered its wings, probably in threat, while fully fluffed and leaning, until the second female flew away. The bird continued to manipulate a seed in its bill while in Level III, and flew away when a cloud once again covered the sun, after four full minutes since its first arrival at the tray.

Only one young Cardinal was recorded at the window tray in the sun during the spring and summer of 1954. At the time of its visit the tray temperature was 117° F., and the bird immediately assumed Level III before flying away. It did not return to the tray again during the sunny hours.

A record made on a very hot day in Fayetteville, North Carolina, August 28, 1954, leads me to wonder if the young Cardinals are "taught" the wisdom of avoiding exposure to the sun. At 3:30 p.m., a female and two young flew to the fence and one young bird hopped down to feed at the grain which was on the grass in full sun. The young bird immediately fell into Level III.

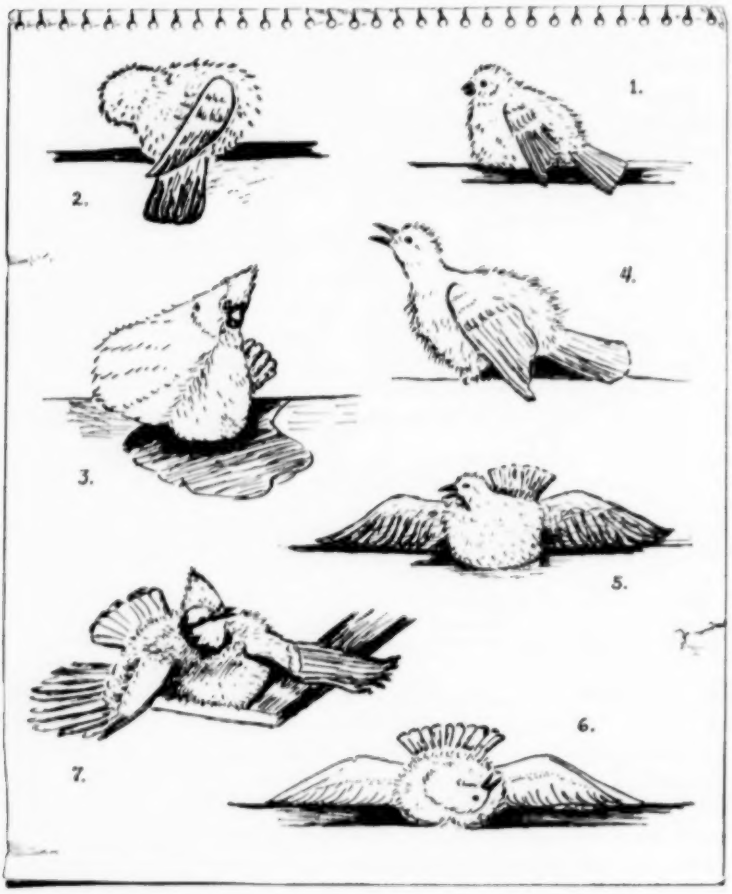

FIG. 1. Sun-bathing postures of some passerine birds sketched by the author. (See text for discussion.) (1) White-throated Sparrow in Level II. (2) Sparrow in Level III, fully fluffed plumage and horizontal lean. (3) Cardinal in Level III. (4) Catbird in Level III. Notice likeness to threat display and courtship display. (5) Mockingbird in Level IV. (6) Mockingbird in Level IV with neck elongated and head turned upside down. (7) Young Blue Jay, in complete collapse on window tray.

A male Cardinal flew in at full speed and, diving down at the young one, chased it up into a tree. Then the male, female and two young birds flew down together and fed in the shade.

Blue Jays began to respond to the sun on the window tray in mid-April, 1954, two weeks later in the season than did the Cardinals, and soon were making their visits so quickly that they often did not land at all, but grabbed a piece of bread while on the wing. One jay, distinctive because of a heavy face molt, was particularly prone to succumb to Level III, although this bird, like the female Cardinal mentioned above, was unaffected when wet from a bath, at a tray temperature of 134° F.

The young Blue Jays did not seem to learn to avoid the tray during the sunny hours, although they were often the most powerfully affected. With wings fanned to the utmost and flapping forward in slow motion, the jays opened their bills and appeared to be both reaching and gasping for air as their body feathers fluffed out and the birds settled flat onto the tray, as though in a state of collapse.

It was not until August 1, 1954, that the Red-bellied Woodpeckers gave any indication of a response to the sun although the males visited the tray daily throughout the summer at all hours. The females had ceased coming to the window in early spring. The response of the young birds was greater than that of the adults. In both, the crown feathers rose first and more fully on the right side, the belly feathers fluffed out, and the right wing was thrown forward flat onto the tray. The birds always left immediately after the wing was thrust forward.

Summer Tanagers[8] (*Piranga rubra*), which are summer residents of the Gainesville area, and Ground Doves, permanent residents, although present on the tray at the same moments as other species mentioned above, appeared never compelled to make any response at all to the sun.

No permanent resident was seen in Compulsory Sun Position in Fayetteville from August 28, 1954, until April 4, 1955, when a female Cardinal assumed Level III at 1:15 p.m., while feeding on the lawn with an air temperature of 67° F.

Responses of Winter Resident Species

The Myrtle Warbler described in the earlier section of this paper was not the last member of the Parulidae to be affected by the sun. By noon of April 12, 1954, I had obtained a fourth record of Myrtle Warblers, including one male in full nuptial plumage, and then they ceased feeding at the tray and fed only at the shaded feeders. All the Myrtle Warblers recorded were affected immediately on landing on the edge of the tray, or as they reached forward for food.

On April 12, 1954, an Orange-crowned Warbler came to the tray twice, at 10:50 a.m. and at 11:55 a.m. On the first visit it fluffed its feathers fully and leaned in Level III immediately, and remained so for a full minute. On the second visit, the bird flew off quickly when its body plumage fluffed and

tail fanned, Level II.

Throughout the rest of that day and the next, this warbler fed only in the shade. On April 14, at 1:45 p.m., it came to the window tray. The crown feathers were raised, the tail fanned, body feathers fluffed out; then the bird flew quickly back to a shrub, two feet away. Its perch here, too, was in full sun, and with its bill wide open and all feathers fluffed out, leaning to the left and, apparently unable to recover, the bird dropped and spread its wings and tail widely. The sun went under a cloud and the bird depressed its feathers, preened briefly and flew to the plum tree where it fed at a suet cup in the shade. This warbler and the few remaining Myrtle Warblers did not visit the window tray again before leaving for the north.

Does this failure to continue feeding at a tray which these warblers had visited daily for several months indicate that they "learned" how they would be affected, and did not want to repeat the experience? Kendeigh (1934:336) says, with reference to temperature tolerances of birds in winter that "A heavy coat of feathers and a thick layer of fat, while serving for better protection of birds in the winter against low air temperature, are at the same time detrimental at extremely high air temperatures because they diminish the radiation of excess heat from the general body surface."

On November 18, 1954, White-throated Sparrows were feeding with House Sparrows at the poultry grain on the lawn. At 12:40 p.m., with an air temperature of 72° F., the sun suddenly came out sharply after three days of rains. Some of the sparrows of both species fluffed their feathers and leaned far to one side as the sun came out. The White-throated Sparrows reacted individually in several different ways (Fig. 1). The first response was always the drop of wings, as described in Level I, while the birds continued to feed; then the belly feathers fluffed out very fully, the crown feathers were raised and the birds leaned far over in Level III. Suddenly a bird would scratch its head violently and resume the fluff and lean. In some cases the bird flew to shade on recovery; in some cases it continued feeding while fluffed. Succeeding days of the same air temperature, with no further rain, brought no such response although the birds fed in full sun.

White-throated Sparrows again responded to the sun from the close of February, 1955, until they left in early May, in air temperatures as low as 55° F. Some of them remained fluffed, in Level III, for as long as three minutes. Many individuals would assume Level III and then subside to preen briefly and feed as many as six or eight times before flying to shade.

This repetition of Level III suggests that there may be sufficient dissipation of body heat after each assumption of the sun-bathing position for the bird to feed again briefly before the rays from the sun once again made it respond.

Discussion

The foregoing records appear to give evidence of what may be an involuntary, compulsory response to the sun on the part of many species of birds. Of primary interest is whether sudden excessive heat is the factor which produces the fluffing of body feathers, crest elevation and fanning of wing and tail feathers at the time of exposure to the sun.

Brown and Davies (1949:92–93) report some observations of the Reed-warbler (*Acrocephalus scirpaceus*):

". . . In sunny weather a few of the nests built on the fringe of the reeds are exposed, usually for short periods of the day only, to full sunshine. Under these conditions the hen bird will shade the chicks by standing in the nest and half opening her wings so that the cup is completely covered. In really hot weather it soon becomes apparent that the hen herself is being severely affected by the heat. The first indication of this distress is a mild form of "panting" with mandibles slightly open, but after a short while the panting increases and the mandibles are open to an angle of as much as thirty or forty degrees. Should a bird in this state continue to shade the chicks, she will suddenly collapse in a most extraordinary manner, lurching over on one side, sometimes closing her eyes and certainly giving the impression that she is on the point of expiring. She then raises the wing on the free side of her body and extends it vertically above her to its fullest extent, the primary feathers standing out like fingers. She maintains this rigid attitude for several minutes, during which she gradually opens her eyes and virtually stops panting. Quite suddenly she closes the wing and stands up in the nest as if nothing had happened and will then either continue to shade the chicks or go off in search of food. In the hot summer of 1947 this curious piece of behavior, which we then believed to be completely original for the species, was witnessed on four or five occasions and two observers were fortunate enough to get photographs, one of the initial stage of collapse, and the other of the bird with the free wing rigidly extended. Quite clearly the stretching up of the wing has beneficial effect upon the distressed bird and it may well be that this serves to expose the sub-clavian vein to the air, thus resulting in direct cooling of the blood."

The response of these nesting Reed-warblers to the sun appears to parallel my own observations closely. The implications of this apparently compulsory response to the sun's rays prompt questions which can only be answered by scientific study.

Are the feathers fluffed in order to expose as much as possible of the outer skin surfaces to the air, to better combat the excessive body temperature? This would be in direct contradiction to the statements of men who had studied the effects of artificially induced heat in birds. Dawson (1954:115) states that "Birds decrease the effectiveness of their insulation by compressing their feathers. They also expose the thinly feathered sides of the thorax by holding their wings away from the body." Likewise, Wallace (1955:40) states: ". . . in warm weather, the feathers are often depressed or held close to the body to allow some escape of body heat."

The response to high temperatures discussed by these authors holds true of birds in shady locations on extremely hot days, as well as in artificially-

controlled cages, but exposure to direct sun appears to evoke an entirely different response that I have called Compulsory Sun Position.

Is this reaction a physiological response generated by the bird's heat-dissipating mechanism? Alternation of Level III with normal composure, described earlier, was a commonplace incident in the case of the White-throated Sparrows on many different days, suggesting that there was sufficient dissipation of body heat after each assumption of the sun-bathing position for the bird to recover and feed until the sun again forced the bird into Level III.

Humidity appears to play a more important part than high air temperatures in the responses that I have recorded. The condition of the individual bird, whether breeding, molting or migrating, appears also to have its effect.

The colors of the birds recorded include almost every shade including iridescent black, a circumstance which would indicate that pigment, or lack of it, was not a determining factor. The only species, feeding when these records were made, which were never seen in Compulsory Sun Position were the Ground Dove, Summer Tanager and Fox Sparrow (*Passerella iliaca*).

The sun plays a vital part in the life-cycle of birds as it does for every living thing. It is hoped that this paper will draw attention to the subject and that observation and study of the effect of the sun on birds will follow.

Acknowledgments

I am deeply obliged to Dr. Keith L. Dixon for his interest in this subject and for his assistance in the preparation of the manuscript. I am also grateful to Mr. John Dennis for his encouragement and notes, and to Drs. Dean Amadon, David Lack, and George A. Bartholomew, Jr., for their helpful suggestions.

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302 Green Street, Fayetteville, North Carolina, March 1, 1956

METHODS AND CRITERIA FOR AGING INCUBATED EGGS AND NESTLINGS OF THE MOURNING DOVE

BY HAROLD C. HANSON AND CHARLES W. KOSSACK

RECENT studies of the Mourning Dove (*Zenaidura macroura*) have indicated the need for better information concerning the migration routes and wintering grounds of the different regional populations in the United States and Canada. Recognition of this need (Kossack, 1955) has resulted in a cooperative program of banding of nestling doves by amateur banders and state and federal workers. Extensive banding operations can be carried out most efficiently if it can be determined in advance when the eggs in various nests will hatch and when the young will be of suitable age for banding. It is hoped that the following descriptive data and photographs will be useful to banders in determining incubation stages of eggs and ages of nestlings. For his excellent work in photographing the nestlings we are indebted to William E. Clark, staff photographer, Illinois Natural History Survey, Urbana.

AGING INCUBATED EGGS

Since 1950, the writers have used portable egg candlers (Hanson, 1954*a*) and a series of reference photographs (Fig. 1) for determining incubation stages in Mourning Doves. The person who may not wish to construct an egg candler can candle an egg with some success by cradling it between the thumb and forefinger and holding it over a two-cell flashlight. The egg can then be examined under a dark cloth or viewed through a tube of adequate size.

The principal anatomical structures that can be observed in viewing incubated eggs of the Bob-white Quail (*Colinus virginianus*) and certain ducks by transmitted light have been shown and discussed in some detail in an earlier report (Hanson, 1954*b*). Because of their relatively small size and white, translucent shells, the eggs of Mourning Doves are particularly suitable for candling. Usually greater detail can be seen in candled dove eggs than in those of the above species.

The daily development stages shown in Figure 1 are believed to represent typical stages, although the field investigator may not always be able to see similar details in eggs being candled. The photographs alone may not always suffice at first to permit an investigator to accurately determine the age of each egg examined. In such cases the notes presented on the characteristics of the various stages of development should be helpful, but they will not be needed after experience is gained. Difficulty, however, will generally be ex-

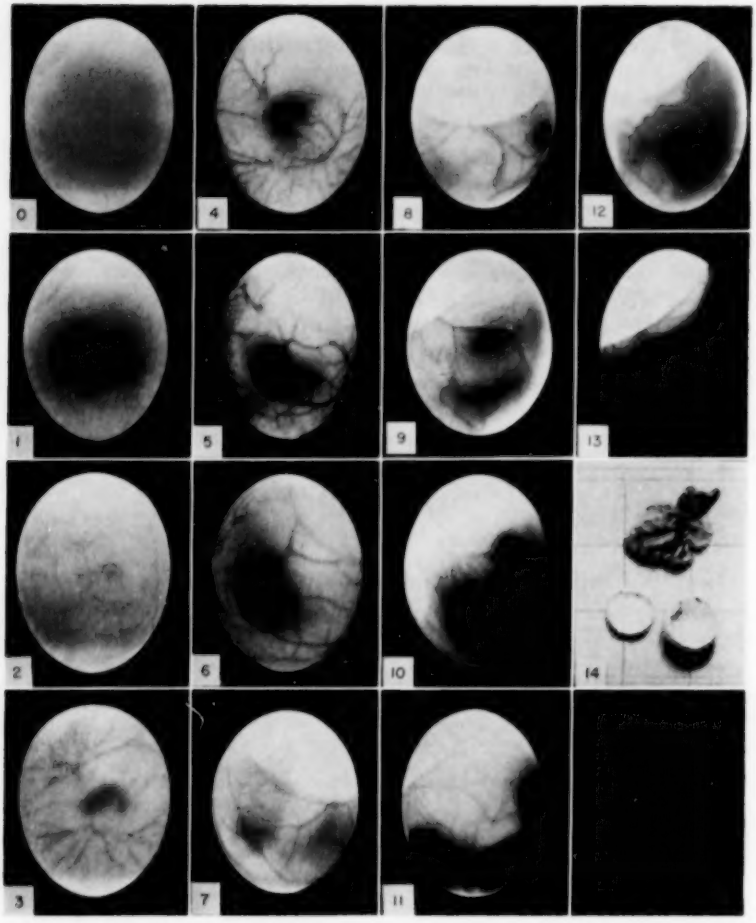

FIG. 1. Incubation stages of Mourning Dove eggs. Days of incubation designated by numerals.

perienced in attempting to make exact age determinations from the seventh through the tenth days of incubation.

There are normally only two eggs in a Mourning Dove clutch and these are usually laid, although not always, a day apart rather than on two successive days. As a result, depending on the incubation habits of the individual pairs, there is normally a difference of about one day in the stages of de-

velopment of the eggs (as well as the hatching, and growth stages of the nestlings). The two eggs also vary in shape and size. Almost invariably the second egg laid is slightly longer and is less oval in appearance than the egg that was laid first (McClure, 1943; Hanson, 1954*a*). For this reason, should the characters of age not be readily seen in candling, it is important that only one egg be accurately aged. The stage of the second egg relative to the first is a reliable clue as to whether it is a day advanced or behind the first egg in incubation.

Incubation Stages

Fresh egg.—Egg shell is usually clean and egg has a translucent appearance in normal daylight. Viewed in the candler, the yolk area is yellow to light orange in color and its boundaries poorly defined.

First day.—Yolk area is more sharply defined and darker orange in color than in the case of a freshly laid egg. This difference is readily apparent in alternately viewing eggs of these two stages in a complete and normal clutch.

Second day.—Embryo is first seen. It appears as a slightly thickened and slightly flexed reddish line 6 to 7 mm. in length. The beating heart is visible at this stage. Distance between anterior vitelline veins is about 10 mm.; *area vasculosa* or yolk sac as delimited by the *sinus terminalis* is about 19 mm. in diameter.

Third day.—Embryo is much thickened and more flexed. Beating heart is still visible. Vitelline veins are now a complete network. Difference between this and the second day stage may best be estimated by comparison of the two eggs in a normal clutch.

Fourth day.—Embryo is 8 to 9 mm. long and about 3 mm. wide; eye is prominent and easily seen. The *amnion* is about 15 mm. in diameter.

Fifth day.—The embryo is not easily seen at this stage due to the fact that it is moving about within the amnion in which it is suspended well below the surface of the egg shell, and is not sufficiently large and opaque unless it lies immediately under the shell. In the latter case, the head and body are apparent as distinct entities. The flexed embryo is about 16 mm. in diameter, and flexes and sways about. The veins of the *allantois*, which has overridden the *yolk sac*, are conspicuous and relatively heavy.

Sixth day.—Distance across (diameter) flexed embryo is about 16 mm.; body of embryo is about 10 mm. in length. This stage and the succeeding two are best determined by the diameter length of the embryo relative to the width of the shell and by the relative length of the neck. The neck is not readily seen but its length is indicated by the position of the head and body of the embryo (see stages 5 to 8, Fig. 1).

Seventh day.—Flexed embryo is 17 to 18 mm. in length; silhouette of head

about 4 mm. Embryo still flexes and sways to some extent, but from sixth day on becomes gradually less active.

Eighth day.—Embryo now lies across the part of the egg distal to the air sac. Movements may be slow or fairly active.

Ninth day.—Embryo is much less active than it was during the eighth day. It is not clearly seen in outline, but often appears as a huddled mass in the central area of the egg.

Tenth day.—Embryo is now curved in a semicircular position, usually against the shell. Head and neck may move some and kicking movements of the feet may be observed.

Eleventh day.—Embryo lies very still, often found stretched out against the shell in the manner shown in Fig. 1, stage 11.

Twelfth day.—Embryo immobilized, fills two-thirds of egg distal to air sac; no detailed structures observable.

Thirteenth day.—The egg is opaque except for the air sac and a small transverse area in which veins can be seen lying immediately above the area occupied by the embryo. Head of embryo later breaks into air sac.

Fourteenth day.—Embryo has hatched, apparently in most cases during the preceding night.

Nestling Growth Stages

Brief notes on the development of nestling Mourning Doves have been presented by Nice (1922) and McClure (1943). The more detailed records presented here, which are based on study of several hundred nestlings, including both captives and wild birds, permit more exact determination of age. In Figures 2 and 3, photographs showing the day by day development of nestling Mourning Doves are presented. Analysis of these records permitted the construction of an "aging gauge," which is shown in Figure 4.

The aging gauge has four scales; the one indicates the average combined length of body and tail of Mourning Dove nestlings of known age; the two other scales are calibrated in millimeters and inches; and the fourth or lower scale is the range in length for birds of a known age. Length and age data are obtained by placing the nestling on the gauge so that the surface of the breast feathers just comes in contact with the end of the vertical stop. The approximate age of the nestling is indicated by the point of terminus of the body—or tail when present.

With the aid of these photographs, the "aging gauge," and descriptive notes given below, the authors had little trouble in determining the age of nestlings through the seventh or eighth day. After the eighth day the problem was more difficult when photographs alone were used, for some of the characters of age were not apparent in the photographs.

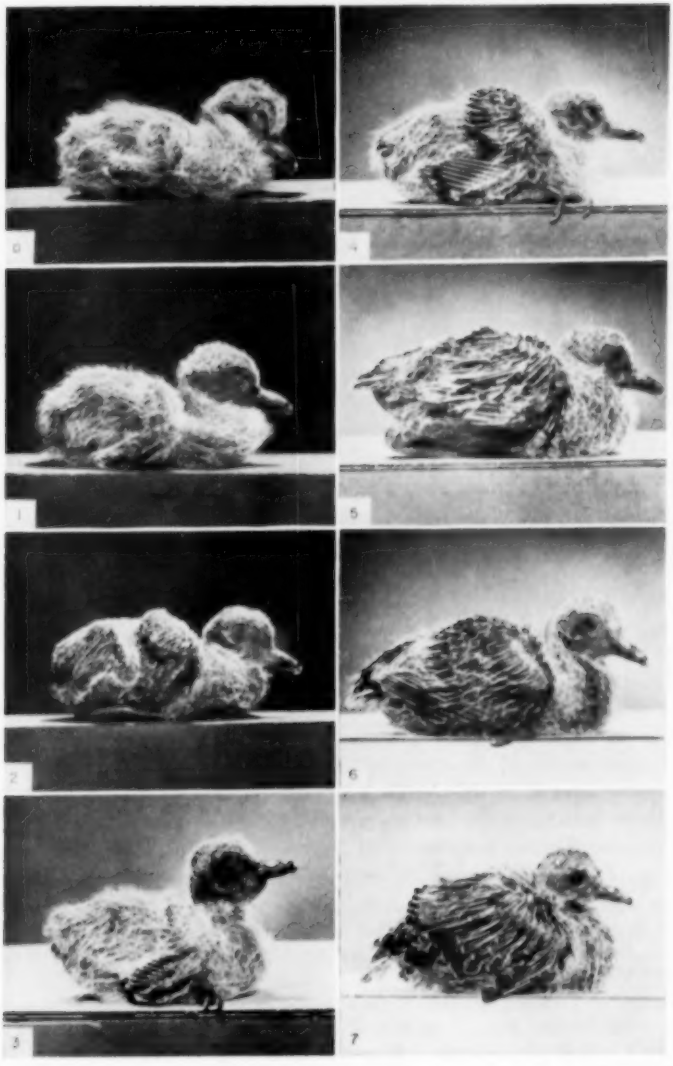

FIG. 2. Growth stages of Mourning Dove nestlings. Age in days designated by numerals.

The tendency in our experience was to overestimate the ages of nestlings nine or more days of age. This factor plus individual variation in size, or stunting, (Fig. 5) emphasizes the need for the combined use of size, plumage and physical characteristics. For example, McClure (1943) noted, as we did (unpublished), that body weight was lower and development was retarded for all nestlings in nests that contained three young as compared with nests that contained two young. Conversely, we have found on several occasions both with wild and captive birds that a single survivor of a clutch may be unusually large and well developed, apparently as a result of an above normal intake of food made possible by lack of competition from a nest mate.

Although it happens infrequently, the younger nestling occasionally grows faster than its nest mate. The writers have measured and marked nest mates when they were two and three days of age. When these nests were revisited and the young were eight and nine days old, the physical development of the younger bird indicated in each case that it was the older. In similar cases in captivity, the younger bird has been observed to be the more aggressive in obtaining food from the parents.

The banding of nestling Mourning Doves at an early age was made possible by the use of "Dalzoflex" elastic adhesive tape (made in England) to hold the bands on the legs (Kossack, 1952). A piece of tape one-half inch wide and sufficiently long to overlap on the band is used. The lower portion of the tape is fastened to the band; the upper portion to the tarsus and to the down feathers on the lower portion of the tibio-tarsus. Half-inch wide plastic adhesive tape has also been used with some success, but it is less desirable than the elastic tape.

In the descriptive notes below, all "lengths" are body length or length of body plus tail (when latter is present) as measured on an aging gauge. Wing measurements are of the straightened and flattened wing, from the bend of the folded wing to its tip. Nestling Mourning Doves have an egg tooth near the tip of both the upper and lower mandibles. For convenience, when both are present, they are referred to as "egg teeth." Reference should be made to Figs. 2 and 3 in reading the descriptions which follow.

Less than one day old (Fig. 2 stage 0).—Length 33 (32 to 35) mm.; not much larger than egg from which it was hatched. Bird has difficulty holding head erect. Eyes closed; egg teeth on upper and lower mandible prominent. Down is cream colored. *Key character.*—Small size.

One day old.—Length 40 (38 to 41) mm. Increased size of wing is principal change in body characteristics. Primary feathers of wing have not appeared. Eyes closed. Both egg teeth present. *Key character.*—Increased size of wing.

Two days old.—Length 49 (45 to 55) mm. Head and body still covered with cream colored down. Skin of wings becoming blue in color. Wing about 19 mm. Primaries just emerging from wing; exposed portion may be 1 to 2 mm. in length. *Key character.*—Emergence of primaries.

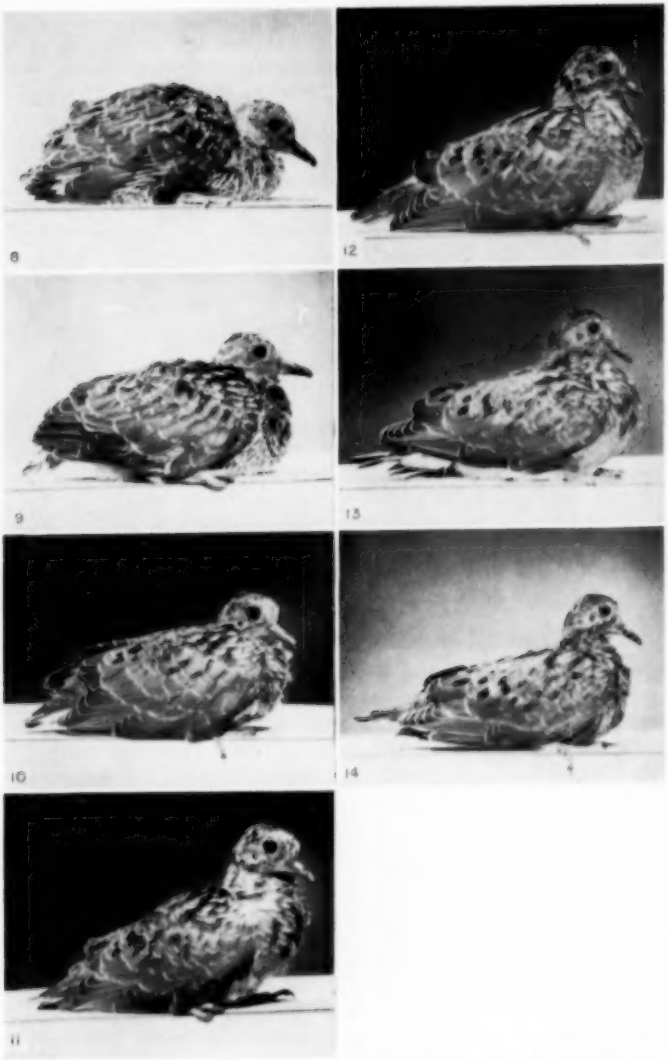

FIG. 3. Growth stages of Mourning Dove nestlings. Age in days designated by numerals. Young doves usually leave the nest when about 12 days old.

Three days old.—Length 55 (51 to 66) mm. Body and head still covered with down, but skin is beginning to take on a bluish cast. Wings are dark blue in color. Eyes one-fourth to one-third open. Egg teeth present. Wing about 23 mm. Sheathed primaries 5 (1 to 12) mm. Tail feathers may be just breaking through skin. Tarsus about the width of a no. 3 band (6 mm.) in length. Band will slip readily over foot. (This is the earliest age in which a band may be applied with the aid of tape. Care should be used in applying tape.) *Key character.*—Length of primaries.

Four days old.—Length 67 (60 to 77) mm. Body still down-covered. Eyes one-third to one-half open. Egg teeth present. Sheathed primaries 13 (5 to 20) mm. Sheathed tail feathers 3 to 7 mm. Secondary wing feathers have emerged. (Band will still slip over foot. This is the ideal age to begin applying bands with the use of elastic adhesive tape.)—*Key character.*—Length of primaries and tail feathers.

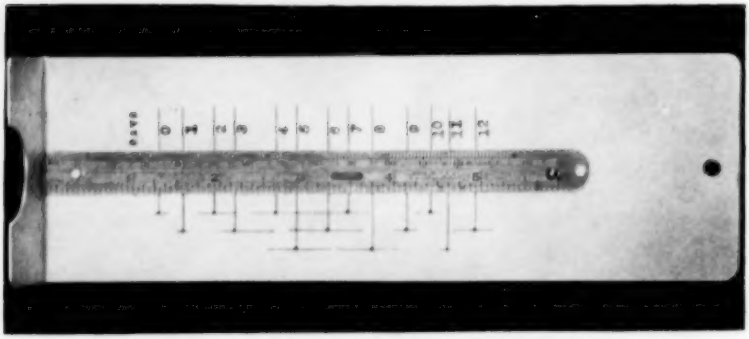

FIG. 4. Gauge for aging nestling Mourning Doves. Average length per day of body, or body plus tail when latter is present, is shown by vertical lines with large numerals. Extremes for these measurements are indicated by the horizontal lines below the center rule.

Five days old.—Length 73 (65 to 83) mm. Eyes are about three-quarters open. Egg teeth are present. Pin feathers (sheathed body feathers) just emerging on upper breast. Scapular feathers sheathed. Sheathed feathers present on spinal tract of back. Wing 47 to 50 mm. Tip of wing folded against the body terminates half way between point of juncture of femur and tail feathers with the body (see Fig. 2, stage 5). Sheathed primaries 24 (18 to 29) mm. Tail 6 (3 to 9) mm. Squabs when taken from nest may crawl about slowly. (At this stage the band will slip over the foot; but tape should be used.) *Key character.*—Wing tip terminates between juncture of femur and tail.

Six days old.—Length 82 (71 to 92) mm. Eyes fully open. Remnants of egg teeth present. Sheathed feathers on crown of head beginning to emerge from skin. A few feathers of spinal tract on lower back begin to emerge from sheaths. Wing about 59 mm. Wing coverts still sheathed. Primaries 82 (71 to 92) mm. Tip of folded wing extends to base of tail feathers (Fig. 2, stage 6). Tips of primaries in some individuals may be just breaking through sheaths. Tail 13 (10 to 17) mm. Young taken from nest now will crawl fast or may take a defensive attitude with wings raised over back. (In banding at this stage, bands should be opened, and then closed on leg and held in place

FIG. 5. Two nestling Mourning Doves, 12 days of age, showing the contrast in size between a nestling of normal development (left) and one whose growth was stunted (right). Respective weights and measurements: normal nestling, 52 grams, wing 100 mm. and tail 41 mm.; stunted nestling, 32 grams, wing 85 mm. and tail 30 mm. The stunted dove was very weak.

by tape.) *Key character.*—Tip of wing extends to base of tail feathers. Tips of primaries begin to emerge from sheaths.

Seven days old.—Length 88 (78 to 94) mm. Egg teeth present but tooth on upper mandible has nearly disappeared. Feathers on crown of head still sheathed. Upper breast feathers and spinal tract feathers partly out of sheaths. Scapular feathers emerging from sheaths. Wing 70 (65 to 73) mm. Primaries 40 (33 to 45) mm. Emerged tips of primaries 8 (3 to 18) mm. Primary wing coverts still in sheaths, but secondary and tertiary coverts becoming free of sheaths. Tail 17 (16 to 21) mm. Nestling will "crawl-run" rapidly. (Band will slip off of leg; use tape.) *Key character.*—Feathering out of tips of primaries and wing coverts.

Eight days old.—Length 95 (85 to 102) mm. Egg tooth occasionally still present on upper bill; always present on lower bill. Feathers of spinal tract free of sheaths to a point about midway up back. Breast feathers just beginning to lose sheaths in appreciable numbers. Wing 76 (73 to 80) mm. Primaries 47 (42 to 49) mm. Primaries free of

sheaths 24 (15 to 28) mm. Primary wing coverts breaking free of sheaths. Gaps appear between primaries when wing is spread, since the primaries have not become sufficiently free of the sheaths to present a completely closed wing surface. Tail 26 (23 to 30) mm. (Band will slip off of leg; use tape.) *Key character.*—Appearance of gaps among wing feathers.

Nine days old.—Length 105 (102 to 108) mm. Egg tooth absent from upper mandible, may still be prominent on lower mandible. Small patch of crown feathers free of sheaths. Upper portion of breast now fairly well feathered out. Ventral tract feathers of belly losing sheaths. Wing 83 (78 to 87) mm. Primaries about 54 mm., free of sheaths for over half their length. Primary feathers of wing now present a continuous surface when spread. Tail about 30 mm. Nestling may leave nest if alarmed. (Occasionally it will be necessary to use tape in banding.) *Key character.*—Feathering out of crown and closing of wing surface.

Ten days old.—Length 112 (108 to 115) mm. Feathers of head (capital) and back (spinal) tracts out of sheaths, but feathers of lower back of neck remain sheathed. Auricular feathers becoming free of sheaths. Wing 89 (85 to 94) mm. Tail 37 (31 to 42) mm. (After the ninth day the young are easily frightened and may leave the nest when disturbed.) *Key character.*—It is doubtful whether the age of nestlings can be judged with any certainty beyond the 9th day. Probably the presence of sheathed feathers on the back of the neck along with the wing and tail measurements are the best indicators of this age.

Eleven days old.—Length about 116 mm. Feathers of ventral tract of belly area becoming unsheathed. Wing about 92 mm.; tail 40 mm. *Key character.*—Unsheathing of belly feathers.

Twelve to 14 days old.—Length about 121 mm. Wing about 99 mm. As McClure (1943:388) states, feather development from the twelfth to the fourteenth days "is that of a refinement, with the completion of feather coverage under the wings and belly and with the development of the fine feather bloom." (From the ninth day on the young may leave the nest when disturbed.)

Summary

Methods and criteria for aging incubated eggs and nestlings of the Mourning Dove are described. With the use of a portable egg candler and the aid of photographs of incubated eggs taken by means of transmitted light, incubation stages, except for 7 through 10 days, can usually be determined with accuracy. Descriptive notes are also furnished as an additional aid in determining incubation stages.

Nestling Mourning Doves were aged by comparing them with photographs of nestlings of known age. An aging gauge showing the average and range of combined body and tail length also proved helpful. Descriptive notes that emphasize the "key characters" of age at consecutive days of growth are presented. The use of elastic adhesive tape in banding nestling doves is also described. Studies of captives and doves in the wild revealed that stunting in nestlings sometimes occurs. Also in some cases, the second hatched nestling may outgrow the first hatched nestling because of the former's more aggressive feeding behavior.

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Illinois Natural History Survey, Urbana, Illinois, October 15, 1956

STATUS OF BREWER'S BLACKBIRD ON THE GRAND PRAIRIE OF EASTERN ARKANSAS

BY JOHNSON A. NEFF AND BROOKE MEANLEY

THE Grand Prairie of eastern Arkansas is described geologically as an upland plain in the Mississippi Valley part of the Gulf Coastal Plain. Comparatively flat, wooded lowlands border the principal drainage streams, but the higher, rather flat uplands are essentially treeless. The area lies mostly in Lonoke, Prairie, and Arkansas counties and is bounded on the west by the Bayou Meto, on the south by the Arkansas River, on the east by the White River, and on the north by Wattensaw Bayou. The name, we are told, was given by early explorers who found here a true prairie where typical prairie grasses grew waist high.

There is little doubt that even in those days of the virgin prairie, Brewer's Blackbirds (*Euphagus cyanocephalus*)—common birds of the more westerly plains—visited the Grand Prairie in winter, but even as late as 1950 there was insufficient information to permit accurate definition of the status of the species in the area. Hollister (1902. *Wilson Bull.*, 9:10–15) reported them at Stuttgart in 1902 and they have been reported by other students intermittently during the intervening years.

Early in 1948 Neff initiated an intensive study of the relationship of blackbirds and other species to the Arkansas rice crop, and in May, 1950, Meanley became resident biologist on the study, with headquarters at Stuttgart. Our task was to study the various species involved and to determine the status of each. During the six years of study much information on the Brewer's Blackbird was assembled.

Few observers on the Grand Prairie recognized the Brewer's Blackbird as a separate species. It was only a blackbird working over the fields, one of the myriad that spends the winter actively scavenging the fallow and stubble fields, or feeding on the plowed or newly-planted oat or lespedeza fields.

In this district, rice is sown in April or May. In earlier years rice was cut with a binder, shocked, allowed to dry in the shock, then threshed; often wet autumn weather delayed threshing till November or December, even occasionally into January. Early in the 1940's, studies were initiated on the artificial drying of rice and by 1948 more than half the state's rice acreage was cut with combine harvesters and dried at the mills. Today fully 95 per cent of the rice acreage is so harvested, and most of the crop is out of the field by mid-October. Binding and shocking remains a fairly common practice only in a few localities.

Oats are planted from September to November, and harvested in June.

Lespedeza is seeded in February or early March and the seed crop is harvested after rice harvest in October or November. A frequent practice is to burn off the stubble and waste straw after combining or before plowing for the next crop.

The Brewer's Blackbird is a common winter resident of the Grand Prairie and of the other open, prairie-like areas found in a number of other eastern Arkansas counties. Fully 10,000 birds wintered within a radius of 25 miles of Stuttgart and there was little or no visible fluctuation in their numbers during Meanley's four winters of observation.

The earliest arrivals come in October (October 6, 1952, October 13, 1951) but true fall migration does not begin before November 1. Flocks that sometimes number 2,000 arrive in the second week of November. In the spring, birds have been recorded in the area as late as April 21 (1951 and 1952); the bulk of them have left the Grand Prairie by late March.

Here, as in its more westerly range, the Brewer's is primarily a bird of the open country. It feeds in plowed fields, fallow land, stubble, and on newly-planted grain fields, and occasionally about cattle feed lots, hog pens, and straw stacks. Essentially ground feeders, these birds were never observed feeding on standing grain, but occasionally fed on shocked rice in the Slovac area (10 miles north of Stuttgart) and on stacks of threshed rice straw.

The feeding locations used most heavily by Brewer's Blackbirds were burned-over stubble fields followed in order by pastures, fall-planted oat fields, plowed fields, rice stubble and miscellaneous sites.

Few Brewer's Blackbirds arrive before rice harvest is completed, and their only attack on the ripe rice crop is upon shocked grain in localized districts. Most of the wintering population has moved northward before any but the earliest rice fields are seeded in the spring, but these birds undoubtedly pick up some of the uncovered seed grain in these early-planted fields.

Most of the Grand Prairie's oat acreage is planted after the arrival of these birds and they pick up only the seed kernels that remain uncovered on the surface of the fields. Damage to oat fields, however, is insignificant. Lespedeza seed does not interest any of the blackbird group and is taken only accidentally; this we have demonstrated by offering lespedeza seed to caged wild-trapped blackbirds which starved to death without taking a weighable amount of the seed.

When the Brewer's Blackbirds arrive in late October some fields of grain sorghum and field corn still are unharvested, but these birds confine their activity entirely to the ground, picking up kernels dropped by Red-winged Blackbirds (*Agelaius phoeniceus*), Brown-headed Cowbirds (*Molothrus ater*) and grackles (*Quiscalus*).

Food Habits

An extensive study was made of the food habits of all blackbird species involved in depredation upon the rice crop. No special effort was made to collect the minor species and at the end of the field work we had a total of 59 stomachs of the Brewer's Blackbird distributed as follows: January, 4; February, 8; March, 7; April, 2; October, 6; November, 26; and December, 6. For this seven-month period, vegetable food items comprised 84.3 per cent of the food, while insects or other animal matter averaged only 14.6 per cent. The value for plant foods is slightly higher than that reported for a five-month winter period by Martin, Zim, and Nelson (1951. "American Wildlife and Plants." p. 174).

Rice, mostly waste grain, comprised 36.5 per cent of the diet in 47 stomachs. Oats, made up 14.6 per cent of the total in 14 stomachs, and field corn and grain sorghum, all waste grain, totalled 22.4 per cent in 31 stomachs.

Seeds of barnyard grass or wild millet (*Echinochloa crus-galli* and *E. colonum*) made up 3.6 per cent in 26 stomachs. Seeds of bristlegrass, paspalum, *Brachiaria*, crabgrass and panic grass were found in 51 stomachs and totalled 4.5 per cent.

Seeds and tubers of nutgrass, spike rush, sedges and other marsh vegetation were found in 13 stomachs but made up less than 1 per cent of the food. Croton seed averaged 1.6 per cent and ragweed seed made up only 0.3 per cent. Miscellaneous seeds included those of dock, smartweed, and some unidentifiable items.

Fragments of grasshoppers and crickets in 18 birds made up 4.7 per cent. Beetles of a number of species were found in 56 birds but in such small quantities that they comprised only 7.9 per cent. In addition to these, weevils of several species (including remains of the rice water weevil, *Lissorhoptrus orysophilus*, a serious rice pest) were found in 16 stomachs and added 0.7 per cent more. The remaining 2.4 per cent animal food was made up of minute quantities of a wide variety of insects including ants, stink bugs, flies and leafhoppers.

The food of the Brewer's Blackbird during its winter sojourn on the Grand Prairie is, therefore, largely made up of waste grain that has little or no value to the farmer. Only a minute quantity of seed oats or rice from newly seeded fields, or of unthreshed grain from shocked rice fields, can be classified as a loss to the farmer. At this season animal food is not abundant, but these birds manage to find a respectable percentage of insects, among them several of the farm crop pests of the Grand Prairie. Few if any of the farmers of the area would deny that this blackbird benefits them during its winter sojourn.

Small numbers of cowbirds, starlings (*Sturnus vulgaris*), redwings or grackles were often noted feeding with larger flocks of Brewer's, but as evening approached these detached themselves and joined the streams of their own species that crossed the evening sky from all directions, all headed for the currently-favored communal roosting thicket. The Brewer's alone remained aloof; only once was a Brewer's Blackbird found roosting in the central roost with the other species.

The Brewer's Blackbird is the last of the wintering blackbird species to go to roost each day—later even than the cowbird. Late in the afternoon an

entire flock might be found perched quietly on a rural telephone line alongside a stubble field; later, in the gathering dusk, the observer may be quite sure that the flock of blackbirds winging low over the stubble in wide circles is made up entirely of Brewer's, and that their chosen roosting site is somewhere in the stubble below them, for grain stubble or reasonably high grass is their preferred roosting cover on the Grand Prairie. This species is a little-known but truly interesting part of the immense wintering blackbird population of the Prairie.

U.S. Fish and Wildlife Service, Denver, Colorado, and Alexandria, Louisiana, April 26, 1956

GENERAL NOTES

Notes, chiefly distributional, on some Florida birds.—In September, 1955, my wife and I spent two weeks observing Florida birds, and taking a few specimens for the Carnegie Museum. In trying to determine which of our observations were worth placing on record I have had to depend largely on Sprunt's "Florida Bird Life" (1954). Although aware that this book has certain shortcomings as a guide to the current status of Florida birds (see Robertson, 1955. *Everglades Natural History*, 3:55–57), I have not had access to other recent information. Dr. Henry M. Stevenson was therefore kind enough to help me select records for publication.

Ardea occidentalis. Great White Heron.—"Straggles north to the Tamiami Trail in late fall and even farther at times, but not to be expected anywhere north of Cape Sable, or Ten Thousand Islands, with any regularity" (Sprunt, 1954:23). As we crossed San Carlos Bay on the Sanibel Island ferry on September 11, we observed a Great White Heron standing in the shallow water just off Punta Rassa, Lee County.

Dichromanassa rufescens. Reddish Egret.—"Occurs sporadically on the mainland at least as far as Lake Okeechobee in the interior. . ." (Sprunt, 1954:29). One was seen with three Little Blue Herons (*Florida caerulea*) on September 9 near the St. Johns River west of Melbourne, Brevard County, along route 192.

Falco columbarius. Pigeon Hawk.—Sprunt's dates for this species range from September 19 on. We saw one on September 14 as it flew east along the north shore of Bahia Honda Key.

Grus canadensis. Sandhill Crane.—This species is supposedly very rare as far south as Everglades National Park. We saw two at very close range on route 27 just 10 road miles beyond the Royal Palm Ranger Station, Dade County (on the stretch of road which is *not* actually within Everglades Park) on September 13. We were gratified at the large number of cranes we were able to see along the road during the course of our visit to Florida, but surprised at the few young of the year seen. For example, in a flock of 18 seen 10 miles north of Okeechobee on September 16, only two were young birds lacking the patch of bright red skin on the crown.

Charadrius alexandrinus. Snowy Plover.—Sprunt (1954:158) gives Estero Island as the southernmost definite nesting locality, and gives no indication whatsoever as to whether there is any migratory movement in this species in Florida. On September 12 we saw a single Snowy Plover on Marco Island, Collier County, some 35 miles south of Estero.

Columbigallina passerina. Ground Dove.—Verheyen (1953. *Bull. Inst. Royal des Sci. Nat. de Belgique*, 29, no. 27) has published an extensive list of species of birds whose skulls he examined to determine the extent of cranial ossification in adults. Among the Columbidae he examined skulls of *Turtur chalcospilos*, *Treron australis*, *Columba arquatrix*, and *Streptopelia semitorquata*. Of these, in the first species only was the "pneumatization" of the adult cranium complete. In the crania of the other three, a "window" was present in each frontal bone. This was also true of a male specimen of *Columbigallina passerina* which I collected on September 9 at the bridge over the Kissimmee River west of the city of Okeechobee. The plumage and soft-part colors of this Ground Dove were those of an adult, and its testes were quite large (left, 9 × 3.5 mm.; right 11 × 4.5 mm.). It would appear that *Columbigallina* may be added to the list of bird genera in which a completely ossified double-layered cranium is not attained with maturity.

Crotophaga ani. Smooth-billed Ani.—On September 8 we discovered a single ani in the scrub on North Merritts Island, Brevard County, along route A1A, 2 miles beyond

the point at which that road leaves route 402. The bird was collected, and proved to be an adult male with testes measuring 9 × 6 millimeters. It was fat, and had been feeding on insects, mostly grasshoppers. This apparently constitutes a new northernmost locality record for this species, which is purely casual in Florida away from the southern Lake Okeechobee area.

Hirundo rustica. Barn Swallow.—On September 10 we were watching a large flock of Barn Swallows hawking insects over an extensive cane field on the Glades-Hendry county line at route 720. Among them, but impossible to collect, was a beautiful albino. As is so often the case in such abnormally-colored birds, the loss of pigment was differential. Although the upper parts were pure white, the areas of the underparts which are pinkish buff in a normal Barn Swallow were a creamy yellow in this bird.

Vermivora ruficapilla. Nashville Warbler.—On September 14 I was attempting to collect one of a small flock of Prairie Warblers (*Dendroica discolor*) at the west end of Bahia Honda Key. It was a particularly windy day, and I found it difficult to keep track of individual birds as they moved about in a small clump of trees. When I finally did fire, the bird which fell proved to be a Nashville Warbler, a species which I had not realized was present among the Prairie Warbler flock. A trick of the wind had conspired to distribute my shot pattern so that the bird was completely mangled. Being unaware at the time of the extreme rarity of this warbler in Florida, I discarded the specimen. I have since learned from Mrs. Margaret H. Hundley of Key West that there are no previous records of this species from the outer Keys. I have also learned never to discard specimens!—Kenneth C. Parkes, *Carnegie Museum, Pittsburgh 13, Pennsylvania, March 29, 1956.*

Golden Eagle attacks decoy duck.—While concealed in a sand-pit duck blind on November 20, 1955, I watched a mature Golden Eagle (*Aquila chrysaëtos*) display unusual interest in some decoy ducks. It was a clear, cold day on the South Platte River near Sedgwick, Colorado, and my 20 decoys (11 mallards fronted by nine pintails) fringing the far side of a 15-foot channel were strung out for 30 feet upstream from my willow-bordered blind. The eagle, soaring into the light wind, came in low over the river bottom and alighted at the water's edge directly across the stream and about 20 feet from me. After a few minutes of critical inspection, head cocked first to one side and then the other, the big bird gingerly waded toward the decoy mallard drake, only five feet away, that brought up the rear of the spread. This first advance into the shallow water abruptly changed to a much faster and ungainly backward retreat as the eagle got its "pants" wet. A second entry into the water and hurried exit to land failed to discourage this hungry bird, for, with two quick beats of spread wings, it was in the air three feet above the water and, passing slowly over the decoys, it landed close to the lead decoy—a bright black and white male pintail.

Here the first half-hearted wading effort was quickly followed by a bold approach to the rear of that pintail decoy, which was slowly tacking with the current. Now the eagle spread its wings, reared back and thrust its feet forward to strike the decoy's back with distended talons. That first vicious strike was repeated as soon as the decoy righted from its half-submerged roll and the scrape of talons on the hard surface of the decoy could have been clearly heard much farther away than my 40 feet. Now, standing in six inches of water and just downstream from the tacking decoy, the eagle gave a sudden wing flap, reached out and grasped the decoy's head with its right foot, and both eagle and decoy were in the air.

Hurriedly, I raised up in the blind as the eagle took wing but I stood motionless when

it dropped the decoy on the shore and alighted nearby. Then, although I was exposed head and shoulders above the blind, the eagle's full attention was on its "prey" for, turning toward me, it walked back to the decoy, now lying on its side, and putting one foot on the "duck," made three sharp pecks at its belly. The noise of the big predator's beak striking the board bottom of that hollow decoy sounded like a slow-motion tattoo of a flicker (*Colaptes*) pounding a house. Finally, apparently convinced that the decoy duck it had "captured" was not edible, the eagle gave up its futile feeding efforts and took to the air, flying leisurely downstream to pass me at eye level and within 10 feet of my face.—Charles C. Sperry, *U.S. Fish and Wildlife Service, Denver, Colorado, April 3, 1956.*

***Telmatodytes palustris plesius* wintering in southwestern Kansas.**—On January 28, 1956, while in Kearny County, Kansas, with four members of a field party from the University of Kansas, I heard an estimated five Long-billed Marsh Wrens (*Telmatodytes palustris*) in a marshy area below the earthen dam of Lake McKinney. Although the water along the perimeter of the marsh was frozen, open areas existed near the center. I collected two specimens, a fat male (K.U. 32991) having minute testes, and a female (K.U. 32992), in which the ovary was four by three millimeters, that had little fat.

The collection at the University of Kansas contains another winter specimen (K.U. 28939), a male, taken one and a half miles north of Fowler, Meade County, Kansas, on December 31, 1948, by Henry Hildebrand. This specimen, previously identified as *T. p. dissaëptus*, and the two birds from Kearny County are assignable to *T. p. plesius* on the basis of the over-all pale coloration, distinctly barred tail coverts, and large size. All three specimens came from the valley of the Arkansas River.

T. p. plesius is known to breed east to central Colorado (A. O. U. check-list of North American birds, 4th ed., 1931:249). Therefore it is not surprising to find it wintering in the valley of the Arkansas River. Many species which breed in the Rocky Mountains occur in that valley in migration or in winter. Western Kansas should be investigated in the breeding season; it would be interesting to know if Long-billed Marsh Wrens breed there and, if they do, to what subspecies they belong.

Tordoff, in his recent check-list of the birds of Kansas (1956. *Univ. Kansas Publ., Mus. Nat. Hist.*, 8 (5):338), lists only *T. p. dissaëptus* as occurring in the state. It is considered an uncommon transient throughout Kansas, known as a breeding bird only from Doniphan County, in the extreme northeastern part of the state. This note records the occurrence, and at least occasional wintering, of *T. p. plesius* in Kansas.—Glen E. Woolfenden, *Museum of Natural History, University of Kansas, Lawrence, Kansas, March 28, 1956.*

"Frightmolt" in a male Cardinal.—The description of the occurrence recorded here has been stimulated by the recent publication of an extensive paper on frightmolt, "Schreckmauser" (Heinrich Dathe. 1955. *Jour. f. Ornith.* 96:5–14). Dathe defines this process as a partial molt which takes place out of the normal molt period and which is set in motion through fright or fear and without any application of force. He gives a long list of birds in which this event has been recorded, stating that it does not seem to have been found among waterfowl or birds of prey. The rectrices are shed most frequently, and next, the smaller feathers of the breast and the dorsal tracts; the wing feathers are seldom, and the feathers of the head, never affected. For the most part, the feathers seem either to be expelled, so to speak, shot away, or, alternatively,

the muscles of the follicle seem to become relaxed so that the quill is set free. Fully formed feathers alone are discarded; regenerating feathers are not lost. Although Dathe ascribes most of his cases to fear, he records an individual cockatoo that "frightmolted" with rage.

My household in Beltsville, Maryland, has for many years scattered feed on the terrace upon which a large glass door opens and which affords a good view from the dining table. Visitors are hence under frequent surveillance. In the late spring or early summer of 1950, a male Cardinal (*Richmondena cardinalis*), flying toward this spot, struck heavily against a casement that had been opened further than usual. The bird fell stunned to the lawn where it was picked up. It had shed the major tail feathers, which lay close by, save the two left lateral-most ones. The Cardinal recovered from his shock and continued as a constant visitor during the entire later season, not replacing the tail plumage. He was easily recognized by the two standing feathers; the absence of the major portion of his flight rudder made little apparent difference to his landings.

The incident discussed above clearly falls into the class discussed by Dathe, and shows also that feather loss is not necessarily a stimulus to regeneration. Probably, however, regeneration would occur at periods closer to the normal molt where, of course, the antecedent activation of the feather papilla is the mover. The entire complex of "frightmolt" is an interesting question which may involve both nervous and humoral participation; the latter is especially suggested in the rage reactions described for the cockatoo.—Mary Juhn, *Jull Hall, University of Maryland, College Park, Maryland, April 25, 1956.*

New bird records for Barbuda, British West Indies.—To my knowledge the last ornithologist to visit Barbuda was Stuart T. Danforth, who spent three days collecting on that island in August, 1933. His activity (1935. *Jour. Agric. Univ. Puerto Rico*, 19 (4):473–482) added seven species to the avifauna known from the island, bringing the total to 54 species. In addition, seven species were listed as doubtfully occurring.

I visited Barbuda from October 29 to November 4, 1955. In spite of the heavy rains which fell at this time, eight species were added to the list recorded from the island, bringing the total to 62 species with seven still carried hypothetically. The additional species are the following:

Coccyzus erythropthalmus. Black-billed Cuckoo.—On November 1, 1955, an immature male was collected about one mile south of Codrington Village. This bird was in the company of Mangrove Cuckoos (*C. minor*) which were fairly common. In a letter to me dated November 21, 1955, Mr. James Bond says: "The former [Black-billed Cuckoo] is an interesting record and it is only the second specimen of the species from the West Indies that I have examined."

Anas crecca carolinensis. Green-winged Teal.—This duck was taken from a flock of 20 small ducks in a rain water pond in the south of the island on October 31.

Porzana carolina. Sora Rail.—I observed one at close range while hunting ducks in a small rain water pond about three miles south of Codrington Village on October 31.

Squatarola squatarola. Black-bellied Plover.—About half a dozen of these plover were observed feeding on the green bordering the lagoon at Codrington Village. They were seen every day during my stay.

Charadrius vociferus. Killdeer.—Two pairs of these birds were observed on several occasions on the green bordering the lagoon at Codrington Village.

Hirundo rustica. Barn Swallow.—A small flock of these swallows could be seen daily coursing over the green at Codrington Village.

Riparia riparia. Bank Swallow.—These little swallows were easily identifiable among the Barn Swallows at Codrington Village.

Progne subis dominicensis. Caribbean Martin.—These birds were reported inhabiting and breeding in the cotton gin building at Codrington Village. They were said to appear yearly. Called "swallows" by the natives. Though this bird was not actually seen, the description given of it and the fact that it nested locally seems to justify its inclusion in this list.

A large hawk, said to visit Barbuda irregularly and reported as very destructive to poultry, is very likely a Duck Hawk. Mr. Danforth lists this bird hypothetically.—G. A. SEAMAN, *Box 472, Christiansted, St. Croix, Virgin Islands, January 9, 1956.*

Status of the Stolid Flycatcher in the American Virgin Islands.—Not until 1943 was the range of the Stolid Flycatcher (*Myiarchus stolidus antillarum*) known to include any of the American Virgin Islands. On June 10 of that year Harry A. Beatty collected a specimen in a ravine near the Bovoni Estate on St. Thomas. At this time he made a call-note count of about 15 birds in the Bovoni ravine area. It was his opinion (1944. *Auk*, 61: 146) that this *Myiarchus* was "faced with extermination through the increasing difficulty of finding holes in trees sufficiently large for their nests as these small islands become more widely denuded of their older forest growth."

In making a wildlife survey of these islands in 1949 the writer located this *Myiarchus* on St. Thomas in the identical area described by Beatty. Nowhere else on St. Thomas has the bird been found by me and until recently it has never been observed on any of the other islands making up the group.

On March 5, 1956, while on the way to Reef Bay, St. John Island, a male *Myiarchus* was collected in a small clearing along the trail which traversed a light, deciduous forest. The taking of this flycatcher on St. John extends its known range through this archipelago nine miles. The bird is now known from Puerto Rico, Vieques, Culebra, St. Thomas and St. John.

Non-migratory and of very sedentary habits, the Stolid Flycatcher remains a seldom seen and rather poorly known bird. Its habitat in the Bovoni ravine, St. Thomas, consists of dense thorn scrub and vines interspersed with a few small, scattered trees clinging precariously to thin soil and rocky hillsides. Since this type of environment is rather common in the Virgin Islands, the fact that this *Myiarchus* confines itself to this one spot on St. Thomas is highly interesting and probably warrants further study.

Some of the heaviest forest left in the Virgin Islands is to be found on St. John. The bird collected there was taken on the outer fringe of this forest where it begins to thin out into scrub. This *Myiarchus* nests in natural cavities in trees or in old woodpecker holes. There would be no woodpecker holes here (since there are no woodpeckers) but inside the nearby heavy forest there might be found suitable conditions for nesting. The habitats where the bird has been found in the Virgin Islands to date are in no way alike, and this fact poses an interesting question as to the exact requirements of this flycatcher.—G. A. SEAMAN, *Box 472, Christiansted, St. Croix, Virgin Islands, April 5, 1956.*

A peculiar type of flight in Cooper's Hawks.—On April 17, 1953, while trapping hawks at the Cedar Grove Ornithological Station in Sheboygan County, Wisconsin, I noticed what seemed to be a very unusual bird which I could not readily identify. Except for its obvious excessive size its method of flight could easily have been mistaken for that of a Nighthawk (*Chordeiles minor*) or more easily for that of a Short-eared Owl

(*Asio flammeus*). In shape and silhouette, however, it was very reminiscent of a Marsh Hawk (*Circus cyaneus*). The bird was a Cooper's Hawk (*Accipiter cooperii*) and in the three years following this event I have seen a repetition of this pecular flight performance at least 17 times.

Since I spend two months during each of the spring and fall seasons at the Station I am in an excellent position to notice such phenomena during the course of our routine observation and banding of migrating hawks. Indeed, all but one of the above observations were of migrating birds at Cedar Grove, whereas the last hawk was seen in Portage County, Wisconsin, by Mr. Alan Hamerstrom, Mr. Lorenz Kramer and myself. This bird also was considered to be a migrant.

All 18 of these observations were made in a total of six days, with the most occurrences on a single day being nine. It is quite likely that in all cases different individuals were involved. Only one of these birds was seen "Nighthawk-flapping," as we have come to call it, in the fall, the other records being in the spring. Seven occurrences were noted in spring 1953, none in 1954, nine in spring 1955, one in fall 1955 and, one in spring 1956. Migrant Cooper's Hawks are normally seen from March 10 to about May 25, but nighthawk-flapping was seen only between April 17 and 21. The sky was clear on five of the six days on which nighthawk-flapping was observed.

Birds flying in this manner usually were seen at somewhat greater heights than those seen in normal migratory flight. In addition, their flight is more erratic, with sudden jogs to one side or the other being quite frequent. Often at this time the hawks fly in long arcs or in large circles, quite in contrast to their normal direct type of flight. Another departure from the normal is the long and narrow appearance of the wing, which acquires a very deep beat much like a butterfly. Ordinarily Cooper's Hawks have quite a rapid stroke but, while nighthawk-flapping, the duration of the wing beat cycle is at least twice as long. Since four of the displaying birds were trapped, resulting in only a minor deviation from our normal trapping percentage, it is doubtful that this behavior is deterrent to our trapping efficiency.

There seems to be no tendency for one sex to indulge in nighthawk-flapping more than the other but, of the nine birds that were aged, only two proved to be first-year birds. Migrant Cooper's Hawks in April, however, are trapped in a ratio of about three adults to one immature.

At least once an adult male and female were seen flying together in this manner, but more often only single birds were seen. All in all with the present evidence it seems doubtful that this is a courtship display but, I am reluctant to speculate on what other purpose it might serve.—Daniel D. Berger, *Cedar Grove Ornithological Station, Cedar Grove, Wisconsin, April 28, 1956.*

Effects of unusual spring weather on Scarlet Tanagers.—The unseasonably cold spring of 1956 in southern New York State pointed up a critical situation in the ecology of the Scarlet Tanager (*Piranga erythromelas*). Consistently cool weather, except for a few days, persisted well into May and culminated with killing frosts on the nights of May 23 and 24 as far south as Yorktown and Thornwood, in Westchester County, where temperatures of 28° F. were recorded in the lowlands. Heavy losses were sustained by florists, nurserymen, orchardists and vegetable gardeners. Weather records reveal that the average dates of the last killing frost are April 20 in southern Westchester and April 30 in northern Westchester County. Similar conditions prevailed in New York City immediately to the south, and in adjacent New Jersey and Connecticut.

The first Scarlet Tanagers normally return to this area from their winter quarters

during the first week of May, the males usually preceding the females by a week or so. Presently the trees are well leafed out, and the birds, concealed above the thick foliage, are feeding vigorously on early caterpillars as they go about their nesting. In 1956 the tanagers returned on their normal schedule, but were greeted by conditions far from customary. The foliage was not advanced, nor were large insects abundant. Tent caterpillars appeared, but these are frequently disdained by tanagers. The hatch of other caterpillars was delayed, but the hordes of warblers present at this time appeared to find an ample supply of small insects for food.

By May 15 the tanagers, particularly the males which had been in the vanguard of the flight, were noted with unusual frequency. And, surprisingly, they were seen mostly on or within a few feet of the ground, foraging for whatever might befall. By May 23 the National Audubon Society, the A.S.P.C.A., and the Bronx Zoo were swamped with inquiries from a curious public. Specimens were brought in, information was sought on proper first aid treatment and on the cause of the phenomenon. On May 25, at four locations in the New York Zoological Park, I observed nine male and four female Scarlet Tanagers; all were near the ground, many congregated about trash receptacles where scraps of food were to be found. They obviously were undernourished; their wings often drooped, they flew reluctantly and with difficulty, and sometimes even clung on vertical tree trunks to rest. Several were brought to the Park for treatment, picked up by hand from the ground, though uninjured. Within a few days they responded to a standard insectivorous bird diet. The public was advised to offer them bread crumbs and raisins, which served as an acceptable substitute.

The cold weather abated by May 29 and conditions for the tanagers improved quickly. By June they had resumed their normal stations in the tree tops where, presumably, their proper food was finally available. They were noted feeding on alate ants and on the larvae of noctuid moths. The crisis caused by a slight fluctuation in temperatures was past, but we have no indication of the mortality attributable to starvation, heavy automobile traffic, or terrestrial predators during this period. The entire episode graphically demonstrates how narrow is the threshold which may, when disturbed, radically affect a natural population.—Richard H. Manville, *New York Zoological Society, Bronx 60, New York, June 9, 1956.*

Hudsonian Godwit in Colorado.—A male Hudsonian Godwit (*Limosa haemastica*), apparently the first of the species to be collected in Colorado, was secured by the undersigned and his grandson, Jack Murphy, along the shores of Clarkson Reservoir at the Mile High Duck Club, Adams County, on May 26, 1956. It was in company with a Lesser Yellow-legs (*Tringa flavipes*), an Avocet (*Recurvirostra americana*) and a Long-billed Dowitcher (*Limnodromus scolopaceus*). Its actions resembled those of the latter bird, but the godwit was noticeably larger and darker. The white band across the lower back was not evident as the bird fed in the shallows. There is a prior observation for the state (*Colo. Bird Notes*, 2[10]:10) by John and Margaret Douglass, a lone bird which they identified as this species, near Jackson Reservoir in Morgan County on May 22, 1955.—Alfred M. Bailey, *Denver Museum of Natural History, Denver, Colorado, June 22, 1956.*

Water moccasin preys on Pied-billed Grebe.—On December 28, 1953, a large water moccasin (*Agkistrodon piscivorus*), was killed in Gulf Hammock, Levy County, Florida. Dissection revealed the presence of an adult Pied-Billed Grebe (*Podilymbus podiceps*) in the alimentary canal.

The omnivorous appetite of this reptile is well known to many who have had the curiosity to examine a number of their partially digested meals, as attested by Allen and Swindell (*Herpetologica*, 1948: 1st suppl.). Although "birds" are not uncommonly listed as prey of this reptile (Ditmars, 1936, "The Reptiles of North America," p. 329, 330; Carr, *Tech. Publ. Univ. Florida, Biol. Ser.*, 3[1]:94) few have cited specific instances as have Adams (1956, *Wilson Bull.*, 68:158) and Carr (1937, *Proc. Fla. Acad. Sci.* 1:86–90) in his delightful essay on the Gulf-Island Cottonmouth.

The unusual size of the species ingested seems worthy of record in this instance.—B. B. Leavitt, *Department of Biology, University of Florida, Gainesville, Florida, July 16, 1956.*

Egg-carrying by the Whip-poor-will.—On June 26, 1956, in Tamworth, New Hampshire, a Whip-poor-will (*Caprimulgus vociferus*) flew from the ground at noon and hovered irregularly back and forth before my face. With tail depressed, the bird's flight was fluttering and moth-like. It alighted parallel to the limb of a fallen tree, approximately four feet above the ground and 10 feet from where I stood. The Whip-poor-will was facing me and holding an egg in full view, beneath its body and against the bark, as my two sons could readily see. Although the bird's feet were not visible, it appeared that the egg was being held with the legs and feet. The Whip-poor-will flew away a minute later, carrying the egg. I now discovered two more eggs lying on dead leaves six or seven feet from where the bird had been perching. One was whole and a chick had just begun to pierce the shell of the second one. The eggs, although shaded, lay adjacent to a bare area exposed to full sunshine, 100 feet from a field, in woods of low growth and slash resulting from hurricane damage.

I returned an hour later. The slash made a quiet approach difficult. The parent bird flew up as before, carrying an egg in the region of its legs and hovering before my face. It again alighted on the limb of the fallen tree, with the egg in full view. Then it flew to a log on the ground, about 25 feet from its nesting site. It perched parallel to the log, with egg pressed against the bark. One downy, brown chick had completely emerged at the nesting place. It made a low "bee-rp" note. I returned again at 2:30 p.m. The Whip-poor-will hovered in hesitating fashion, then perched cross-wise on a limb behind me. It was not carrying an egg. A chick and an egg were at the nesting site. It appeared possible that the bird had lost its third egg when flying away with it at the time of my second visit. The second chick had hatched by the following morning. On June 28, the parent bird fluttered in front of me, then perched cross-wise to a limb with wings drooping and, with throat puffed out, gave a grotesque appearance. It made several low notes; a "chuck," a "qu-irk," and a "qu-irr." The two chicks were a few inches from where they had been located originally.

The above incident appears of interest because of the scarcity of recorded information on how a Whip-poor-will may carry an egg and the fact that three eggs were present. Although I have encountered no adequate descriptions of egg-carrying in related birds, Dr. Herbert Friedmann has furnished the following reference regarding an African coucal (1929, *The Bateleur.*, 1:29). "Mr. C. Giles reports that a coucal (probably *Centropus superciliosus*) at Kampala, Uganda, removed its chicks one by one to a place of safety, when the elephant grass in which its nest was constructed was on fire, by carrying each one in turn between her thighs. Mr. Giles is most emphatic in describing what he observed and is certain that the adult bird did not carry the chicks in her feet."—Lawrence Kilham, *7815 Aberdeen Road, Bethesda 14, Maryland, July 10, 1956.*

Varied Thrush in Texas.—A male Varied Thrush (*Ixoreus naevius*) appeared under the hedge in my yard in El Paso, Texas, on February 12, 1956, and remained as a visitor until March 21, 1956. At first he was very shy and stayed well under cover, but within a day or two he was feeding openly on the mixed grain I had put out for sparrows, pausing now and then to drive away the sparrow nearest to him. Before long he became so tame that he would fly only a short distance when anyone approached. I saw him only once at the bird bath. He seemed to prefer to drink from the end of the hose and I often let it run just for his benefit. Early in March Mr. Dewitt Johnson set up a blind in the yard. Mrs. Johnson spent two mornings in it and obtained a sequence of colored movies. In addition to the colored movies, two different persons obtained recognizable pictures during the early part of the thrush's sojurn so there is absolutely no question as to the correct identification.

This is believed to be the first authenticated record of the Varied Thrush in Texas. However, Mrs. E. W. Miner (1946. "Bird Check-list of Southeast Texas, p. 26) reported sight records at Cove, Texas, on November 4, and 6, 1935. The species is not mentioned by Wolfe (1956. "Check-list of the Birds of Texas").—Mary Belle Keefer, *3027 Federal St., El Paso, Texas, August 1, 1956.*

WILSON SOCIETY NEWS

It is with deepest regret that we report the death of Josselyn Van Tyne on January 30, 1957. In addition to his accomplishments as an ornithologist, Dr. Van Tyne will be remembered for his unstinting service to the Wilson Ornithological Society. He served as President, 1935–37, and as Editor of *The Wilson Bulletin*, 1939–48, but he also performed a myriad of tasks in an unobtrusive fashion and his advice was sought invariably in the affairs of the Executive Council. As a memorial to Dr. Van Tyne, the American Ornithologists' Union has established the Van Tyne Research Fund. Contributions may be sent to Dr. Philip S. Humphrey or to Dr. Robert W. Storer, Museum of Zoology, University of Michigan, Ann Arbor.

We learned with regret of the death of Lawrence E. Hicks on January 20. Dr. Hicks served as President of the Wilson Society, 1940-41.

1957 ANNUAL MEETING

Members of the Wilson Ornithological Society are reminded that the annual meeting for 1957 will be held on the University of Minnesota Campus at Duluth, June 13–16. Duluth is situated in the coniferous forest region, and field trips are planned to wilderness areas where species such as Arctic Three-toed Woodpecker, Brown-capped Chickadee and Spruce Grouse may be found. A variety of activities has been planned and the details of these will be presented in an announcement that will be mailed to members shortly. Plan now to attend and to participate in the program.

LOUIS AGASSIZ FUERTES RESEARCH GRANT

Application forms for the 1957 Louis Agassiz Fuertes Research Grant may be obtained from the chairman of the Research Grant Committee of the Wilson Ornithological Society, Dr. Kenneth C. Parkes, Carnegie Museum, Pittsburgh 13, Pa.

A detailed account of the history of the Grant and the criteria by which applications are judged was published in the December, 1955, issue of *The Wilson Bulletin*, pp. 307–308. Briefly, $100 is awarded annually by the Society to aid in the completion of the ornithological research project which, in the judgment of the Committee, seems most likely to make an important contribution to ornithological science. Affiliation with a university is not required; the Committee particularly solicits applications from non-student amateurs.

Deadline for applications for the 1957 Grant will be May 20. The Committee's decision will be announced at the annual meeting at Duluth on June 13, and published in the September issue of *The Wilson Bulletin*.

The University of Oklahoma announces that a grant from the National Science Foundation has provided funds for a number of grants-in-aid to be awarded to competent students and investigators in biology for the 1957 summer session at the University of Oklahoma Biological Station, Lake Texoma. Three types of grants are available: (1) postdoctoral grants of $500; (2) predoctoral grants of $350; (3) $200 grants to superior undergraduates or beginning graduates. The investigations pursued must be suitable for the Biological Station.

Applications for grants-in-aid should be made by April 10, and should be sent to: Carl D. Riggs, Director, University of Oklahoma Biological Station, Norman, Oklahoma.

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ORNITHOLOGICAL LITERATURE

PHEASANTS IN NORTH AMERICA. Edited by Durward L. Allen. The Stackpole Company, Harrisburg, Penn., and the Wildlife Management Institute, Washington, D. C., 1956: 6¼ × 9¼ in., xviii + 490 pp., illus. $7.50.

This book is published as a successor to W. L. McAtee's "The Ring-necked Pheasant and Its Management in North America" (1945). It follows somewhat the plan of the earlier work but, by intent, the authors are different from those of McAtee's book. The book is illustrated by 82 fine plates, 33 figures, and a colored frontispiece reproduced from a painting by Bob Hines, who also contributed the excellent sketches which head each chapter. The bibliography lists 249 references and the book is concluded by a detailed index of subjects and authors.

In Chapter 1, Fred H. Dale clearly summarizes the present knowledge of the life history and biology of the Ring-necked Pheasant in North America. In Chapter 2, J. Burton Lauckhart and John W. McKean present a lucid discussion of the pheasants in the northwestern United States and British Columbia. Chapter 3, by Chester M. Hart, Ben Glading, and Harold T. Harper, deals entirely with California. Lee E. Yeager, Jessop B. Low, and Harry J. Figge discuss the pheasants in the arid southwest in Chapter 4. In Chapter 5, James W. Kimball, Edward L. Kozicky, and Bernard A. Nelson write about the pheasant in the mid-western prairie states. Chapter 6, the longest chapter in the book, on the pheasants in the Great Lakes region, is by Robert A. McCabe, Ralph A. MacMullan, and Eugene H. Dustman. In Chapter 7, Allen W. Stokes presents an account of the pheasant populations on Pelee Island, Ontario. Chapter 8, by Allan T. Studholme and Direk Benson, covers the pheasant in the northeastern United States. Finally, in Chapter 9, the editor sums up the pheasant management outlook.

The seven chapters which deal with various geographical regions of North America follow the same general form. Each discusses the establishment of this exotic in the region and each includes a description of the present distribution and relative density of the birds. Each chapter also includes an excellent description of the habitat, a discussion of fluctuations in the numbers of the birds, consideration of limiting factors and possible causes for population fluctuations with, occasionally, some general discussion of population dynamics, and, finally, a discussion of management problems.

In the introduction, C. R. Gutermuth states that the book ". . . will provide answers to almost any of the questions of all those interested in this exotic . . ." and that it will be of especial interest to wildlife students, fish and game technicians and administrators, game breeders, and sportsmen. It is not surprising that a book attempting to meet such an ambitious goal and aimed at satisfying such a wide audience should fall somewhat short of the mark. Although the book contains a great deal of information about pheasants, it still leaves many questions unanswered. It also fails to meet the needs of the wide audience for which it was intended, since it is obviously a technical work written *by* technicians *for* technicians. Such concessions as seem to have been made to the sportsman appear only to have decreased the technical value of the book without making it more intelligible to him.

For the technically minded, this book is an important summary of the existing knowledge and present day philosophy of pheasant research and management in North America. For the neophyte, the bibliography is a good general summary of the literature on pheasants through 1953. All who read this book will glean much from the excellent habitat descriptions for the various regions and from the discussions of the distribution and fluctuations of pheasant populations in these habitats. Wildlife biologists, especially,

should gain much from the broadened perspective which they will gain from this work and the critically minded readers with a bent for research should be excited by the challenging problems which remain to be solved.

There are a few deficiencies in the book which detract, somewhat, from its usefulness. There is a lack of uniformity in expression of sex ratios and numbers of birds per unit area. The regional distribution maps are interesting diagrams of pheasant distribution but the break-down into birds per 100 acres is largely wasted effort since no indication is given as to the season represented. Information regarding band recoveries is often difficult to interpret since the birds released often are not described, the time of release is frequently not given, and often no information is presented regarding the method of release, the release areas, hunting pressure or method of band recovery. The excellent maps in Chapter 5 showing the east-west changes in pheasant populations during the 1940's are marred by being broken-down into population densities described as being low, medium, high, very high, and excessive. Terms such as these represent a point of view and as such may be meaningful to the authors today but even to them they may not have the same meaning that they did a decade ago or that they will a decade hence.

A few editorial errors occur but they do not detract unduly from the value of this work. These include some inconsistent table headings, some grammatical and typographical errors, an awkward placement of several tables, a paragraph in each of Chapters 6 and 8 which seems to have been misplaced, an error in numbering Figures 19, 20 and 21 in the text and the omission of a cited reference from the bibliography. More important is the fact that no references are cited for some of the information and conclusions presented in this work and, as a result, few but biologists currently engaged in pheasant work will be able to evaluate these for themselves.

The philosophy underlying much of present-day game research and management, as indicated in this book, is important. Throughout this work the underlying concept of population dynamics appears to be an extremely simplified one involving a carrying-capacity which is apparently a definite population level and which appears to be determined by the numbers and distribution of obvious, relatively easily measured environmental things but which seems to be largely unaware of obscure environmental factors and, except in a very superficial manner, of the biology and psychology of the animal being considered. There is often a tendency also to accept as fact certain theories which have been advanced by researchers to explain population phenomena observed on specific areas over relatively short spans of time. Some of these hypotheses, due perhaps to having been advanced by well known biologists or to having been in use for a long time, have acquired the status of ecological principles in wildlife thinking. As a result, conclusions are drawn at times from rather brief studies, particularly if the results of these studies seem to agree with the "principles," while at other times data which seem not to support the "principles" often appear to be overlooked. Thus we discover a statement being made regarding limits on pheasant populations (Chapter 9) which is based on a three-year study but find no mention of further data from the same area which would seem to require modification of any conclusions which might be based on the earlier work.

From this process certain characteristics of pheasant populations for which no research data seem to be available are postulated and management programs are developed. This type of reasoning seems to be the basis for conclusions such as ". . . where only cocks are shot, nearly all topgrade ranges are supporting an excess of hens that cannot be as effective as breeders." (p. 460). Two somewhat similar statements are: "Between incubation time and October, on many ranges it takes about two eggs to make one sub-

adult bird. This means that Nature has overproduced by 100 per cent to allow for a loss of half the crop between May and hunting season." (p. 436) and "Under ordinary conditions we can assume that Nature does a large overstocking job and natural limitations cut the annual production down to a size that will fit a given environmental pattern." (p. 437). No specific data are cited to support these conclusions, though this may be due to an attempt to make the text more readable for the non-technical audience, and they seem to be the basis, in part, for liberalizing the hunting seasons and for shooting hens in some areas where they would crowd a restricted winter habitat and overproduce the following breeding season. Stocking as a management procedure, except for commercial shooting areas, is generally discouraged, as are pheasant sanctuaries. State-wide habitat management programs are the rule at present and annual changes in hunting regulations seem to be regarded as unnecessary since when populations are low hunters stop hunting and take little game and ". . . it appears that getting the available surplus of cocks into the game bag is a much greater problem than preventing hunters from killing too many." (p. 463).

These remarks are intended to be entirely impersonal and are not intended to be critical of the authors or the editor of this book. They are intended to suggest, however, that this book, rather than being a final report which answers almost all questions about pheasants should, in fact, be considered a progress report which faithfully, and in a very excellent, readable manner, summarizes the present-day knowledge and philosophy of pheasant research and management. They are also intended to suggest that, while much progress has been made, there is still a vast *terra incognita* awaiting an enthusiastic, energetic explorer who can approach the problems with a fresh viewpoint. This book should be in the library of everyone interested in wildlife and it becomes, at once, a part of the necessary impedimenta of every game manager and administrator who has pheasant problems and of every technician working on a pheasant project. The editor is to be commended for performing well a big job, the completion of which has produced an extremely valuable contribution to the wildlife field.—Robert A. Pierce

Check-list of the Birds of Texas. By Col. L. R. Wolfe. Published by the author at Kerrville, Texas, 1956: 6 1/8 × 9 1/4 in., 89 pp., map. $1.75.

The purpose of this compilation is to provide a list of the species and races of birds reported reliably from Texas and to outline briefly the distribution of each within the state. The author lists only those forms recognized by the Check-list Committee of the American Ornithologists' Union. Details of the circumstances of record are provided for most of the species which have been reported infrequently from the state. However, for others, such as the Rivoli Hummingbird, the pertinent details would have required little more space than that taken by the statement "several specimens have been taken during the summer."

The distributional data in most instances are reported by the system of eight regions defined for administrative purposes by the Texas Ornithological Society; a map of these areas is provided. Even though these "areas" may be considered as having relatively uniform ecologic conditions, the designation of geographic ranges by such a system leads to vagueness. For many species this is a reflection of the lack of precise data on the limits of the range in the state, but I feel that the mention of counties of actual record would have been more effective. In addition to some indefinite distributional references, the author is prone to rely on the probability of occurrence in the assignment of ranges. For example, the Mountain Chickadee is stated to be "Resident in area 4" (trans-Pecos Texas), whereas it has been reported breeding only in the Guadalupe Mountains (in the northern

part of the area) and once in winter in the Davis Mountains further to the south. The citation of a definite locality of record followed by a phrase "is to be looked for" in nearby areas, would seem preferable.

In a few cases reliance has been placed upon records which have not been substantiated in recent decades. Bachman's Sparrow is listed as a summer resident in some parts of central Texas that are rather sparsely wooded, apparently on the basis of Lloyd's report (1887. *Auk*, 4:292). I know of no recent specimen records for central Texas. However, the paucity of information concerning the distribution of this and some other species is considerable.

In reviewing a work with the distribution of a group in an area as large and diverse as Texas one tends to seek out the flaws and to pass over the bulk of satisfactory text. Persons interested in the ornithology of Texas owe Col. Wolfe a debt of gratitude for providing a firm basis for future work on the distribution of birds in that state. It is hoped that ornithologists with notebook records or unreported specimens will publish their data or report them to Col. Wolfe so that a revised list with more precise range definitions may be forthcoming.—KEITH L. DIXON.

AN ANNOTATED BIBLIOGRAPHY OF NORTH DAKOTA ORNITHOLOGY. By T. C. Stephens. Published by William Youngworth as Occasional Papers, No. 2, Nebraska Ornithologists Union, Crete, Nebr., 1956: 8½ × 11 in., 2 + 22 pp. multilith. $1.00.

A chronological list of 267 titles, 1858-1947, and brief account of the author. In many of the references the species concerned are noted. References that have been re-checked are indicated and some are noted as "not seen". Through some oversight the years 1932 and 1933 are included in 1931.

It is unkind to criticize such a posthumous and apparently meritorious work but some discrepancies should be noted. Dr. Stephens apparently had not seen Coues' Field Notes of 1873-74 but it is hard to understand how he could have dismissed this important paper with "Uncertain if there are any explicit North Dakota Notes."

The references to Mrs. Bailey's series in the *Condor* include only 3 of the 17. Essential references missing include Bailey's Biological Survey of North Dakota, Swenk and Stevens on Harris' Sparrow, William's list from the Red River Valley, Reid's Birds and Mammals observed by Lewis and Clark, notes in Maximilian's travels, and in Audubon's journals.

Dr. Stephens probably was not aware of a manuscript bibliography to 1928 compiled by Russell Reid, a copy of which was deposited in the library of the North Dakota Agricultural College. This contains 168 entries, arranged alphabetically, and includes many additional titles.—O. A. STEVENS.

This issue of *The Wilson Bulletin* was published on March 30, 1957.

EDITOR OF THE WILSON BULLETIN

KEITH L. DIXON
Department of Wildlife Management
Agricultural and Mechanical College of Texas
College Station, Texas

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SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the color-plate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A WORD TO MEMBERS

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the 'suspended list.' Postage is used in notifying the publisher of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated on the mailing list and there is a publisher's charge for this service. The Bulletin will become larger if members will make a point of paying their dues promptly.

NOTICE OF CHANGE OF ADDRESS

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia. He in turn will notify the publisher and editor.

Your 1957 vacation plans should include

THE THIRTY-EIGHTH ANNUAL MEETING

which will convene on the campus of

THE UNIVERSITY OF MINNESOTA, DULUTH BRANCH

DULUTH, MINNESOTA

June 13–16

Sponsors:

Minnesota Ornithologists Union
University of Minnesota, Duluth Branch
Duluth Bird Club

In 1958, the Society visits Oglebay Park, Wheeling,
West Virginia, from April 24–27